# Missouri Department of Natural Resources Water Protection Program

# Total Maximum Daily Load (TMDL)

# for

# Blue River and Indian Creek Jackson County, Missouri

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**DRAFT Total Maximum Daily Loads (TMDLs)**
**For Blue River and Indian Creek**
**Pollutant: Bacteria (*E. coli*)**

**Names:** Blue River
Indian Creek

**Location:** Near Kansas City in
Jackson County, Mo.


State Map Showing Location of Watershed

**Hydrologic Unit Code:** 1030010101

**Water Body Identification Numbers:**
**and Missouri Stream Classifications[1]:**

0417 – Blue River P
0418 – Blue River P
0419 – Blue River P
0421 – Blue River C
0420 – Indian Creek C

**Designated Beneficial Uses:**

- Livestock and Wildlife Watering
- Protection of Warm Water Aquatic Life
- Protection of Human Health (Fish Consumption)
- Whole Body Contact Recreation – Category A (0419 and 0420)
- Whole Body Contact Recreation – Category B (0417, 0418 and 0421)
- Secondary Contact Recreation (0418, 0419 and 0421)
- Industrial (0417, 0418 and 0420)

**Pollutant and Impaired Use:**

- Bacteria (*Escherichia coli* or *E. coli*) – Whole Body Contact Recreation (A and B) and Secondary Contact Recreation (WBID 0419).

**Lengths and Locations of Impaired Segments[2]:**

0417 – 4.4 miles, Mouth (Sec. 29, T50N, R32W) to Guinotte Dam (Sec. 6, T49N, R32W)
0418 – 9.4 miles, Guinotte Dam (Sec. 6, T49N, R32W) to 59th Street (Sec. 2, T48N, R33W)
0419 – 7.7 miles, 59th Street (Sec. 2, T48N, R33W) to Bannister Road (Sec. 28, T48N, R33W)
0421 – 12 miles, Bannister Road (Sec. 28, T48N, R33W) to State Line (Sec. 31, T47N, R33W)
0420 – 3.4 miles, Mouth (Sec. 28, T48N, R33W) to State Line (Sec. 31, T48N, R33W)

[1] Class P streams maintain flow even during drought conditions. Class C streams may cease to flow in dry periods but maintain permanent pools that support aquatic life. See Missouri Water Quality Standards 10 Code of State Regulations [CSR] 20-7.031(1)(F)4 at: www.sos.mo.gov/adrules/csr/current/10csr/10c20-7.pdf.

[2] Lengths of impaired segments reflect full classified water body lengths as per Missouri's Water Quality Standards (10 CSR 20-7.031 Table H) effective October 2009, and approved by the U.S. Environmental Protection Agency, or EPA, on August 16, 2011. These lengths differ from those identified as approved by EPA on the 2010 303(d) List of impaired waters, which incorrectly lists mileages from an earlier version of Missouri's Water Quality Standards.

## Contents

## Figures



## Tables

# 1 Introduction

The Blue River and Indian Creek Total Maximum Daily Loads, or TMDLs, are being established in accordance with Section 303(d) of the federal Clean Water Act. These water quality-limited segments flowing through Kansas City in Jackson County, Mo. are included on the U.S. Environmental Protection Agency approved Missouri 2010 303(d) List of impaired waters.

The purpose of a TMDL is to determine the pollutant loading that a water body can assimilate without exceeding the water quality standards for that pollutant. Water quality standards are benchmarks used to assess the quality of rivers and lakes. The TMDL also establishes the pollutant loading capacity necessary to meet Missouri water quality standards based on the relationship between pollutant sources and in-stream water quality conditions. The TMDL consists of a wasteload allocation, a load allocation and a margin of safety. The wasteload allocation is the portion of the allowable pollutant load that is allocated to point sources. The load allocation is the portion of the allowable pollutant load that is allocated to nonpoint sources. The margin of safety accounts for the uncertainty associated with water quality model assumptions and data limitations.

Blue River was originally listed as impaired by chlordane on Missouri's 1998 303(d) List of impaired waters. A TMDL was completed by the Missouri Department of Natural Resources and approved by EPA in 2001. The currently identified impairment for bacteria was first placed on the 2004/2006 303(d) List, with the source of the impairment identified as urban runoff. For the 2010 303(d) List the identified source has been modified slightly to urban nonpoint source.

Indian Creek was originally listed as impaired by fecal coliform on Missouri's 2002 303(d) List. This pollutant was revised to bacteria for the 2004/2006 List after the criterion used for establishing recreational use was changed from fecal coliform to *E. coli* bacteria in Missouri's 2005 Water Quality Standards. In addition, chloride was added as a pollutant on the 2004/2006 List and a TMDL to address the chloride impairment is scheduled to be developed in 2014. The sources of the bacteria impairment have been identified as originating from multiple point and nonpoint sources.

The city of Kansas City, Mo. is operating under a consent decree[3] settlement, lodged in the U.S. District Court for the Western District of Missouri on May 18, 2010, to address ongoing violations of the federal Clean Water Act. There are currently about 87 identified combined sewer overflow outfalls that are authorized to discharge to the Blue River watershed during wet weather conditions. The consent decree compels the city, among other things, to implement its Overflow Control Plan which was developed by the city's Water Service Department to reduce or eliminate overflows of untreated sewage from the city's wastewater collection and treatment system, and to reduce the levels of pollutants in area streams contributed by urban stormwater. The plan acknowledges that these goals require an adaptive watershed management approach incorporating not only conventional source reduction techniques, but also emerging strategies such as development and use of green infrastructure and stormwater best management practices,

[3] *United States of America v. The City of Kansas City, Missouri*, No. 4:10-cv-0497-GAF, May 18, 2010.

or BMPs. To that end, early implementation of the plan is slated to begin with a focus on the Blue River watershed, including development of a Blue River Watershed Management Plan, as well as the Middle Blue River Basin Green Infrastructure Pilot Project, which is already underway (Kansas City 2009). The Overflow Control Plan was completed in January of 2009, and is scheduled to be implemented over the course of 25 years or more.

Blue River is also currently on the Kansas 303(d) List of impaired waters, where it is identified as violating that state's water quality criteria for dissolved oxygen and mercury. It has previously been listed for impairments to aquatic life and recreational use (due to fecal coliform), and TMDLs to address these impairments were completed and approved by EPA in 2001. Indian Creek is also currently identified on the Kansas 303(d) List as violating that state's water quality criteria for total phosphorus and chloride, and previous TMDLs approved in 2001 have addressed fecal coliform and nitrate impairments.

# 2 Background

This section of the report provides information on the Blue River watershed, including Indian Creek.

## 2.1 The Setting

Blue River is formed from the confluence of Wolf Creek and Coffee Creek in Johnson County, Kan. and flows northeast for about 40 miles to its mouth at the Missouri River in Jackson County, Mo. In Kansas, Blue River flows along the southern boundary of the city of Overland Park, and in Missouri the river flows through Kansas City. The whole length of the Blue River in Missouri is comprised of four classified stream segments totaling 33.5 miles (see page ii). Blue River drains a predominantly urban watershed of roughly 275 square miles, comprised of 113 square miles (41 %) in Missouri and 162 square miles (59 %) in Kansas (Figure 1).

Indian Creek is a tributary to Blue River. With its headwaters also originating in Johnson County, Kan., in the city of Olathe, it flows east for about 23 miles to its confluence with Blue River. The majority of the length of Indian Creek is in Kansas, with the portion in Missouri being a 3.4 mile long classified segment The location and extent of the Indian Creek watershed can also be found in Figure 1.

The impaired length of Blue River in Missouri is 33.5 miles and the impaired length of Indian Creek is 3.4 miles, the full length of the classified segments for each of these water bodies in Missouri (see footnote 2). The classified segments correspond to those portions of the stream defined in Missouri's water quality standards (10 CSR 20-7.031 Table H); the impaired segments correspond to those portions of the stream determined to not be meeting water quality standards. In the case of Blue River and Indian Creek, the lengths of the classified segments and impaired segments are the same. (Missouri Secretary of State, 2009).

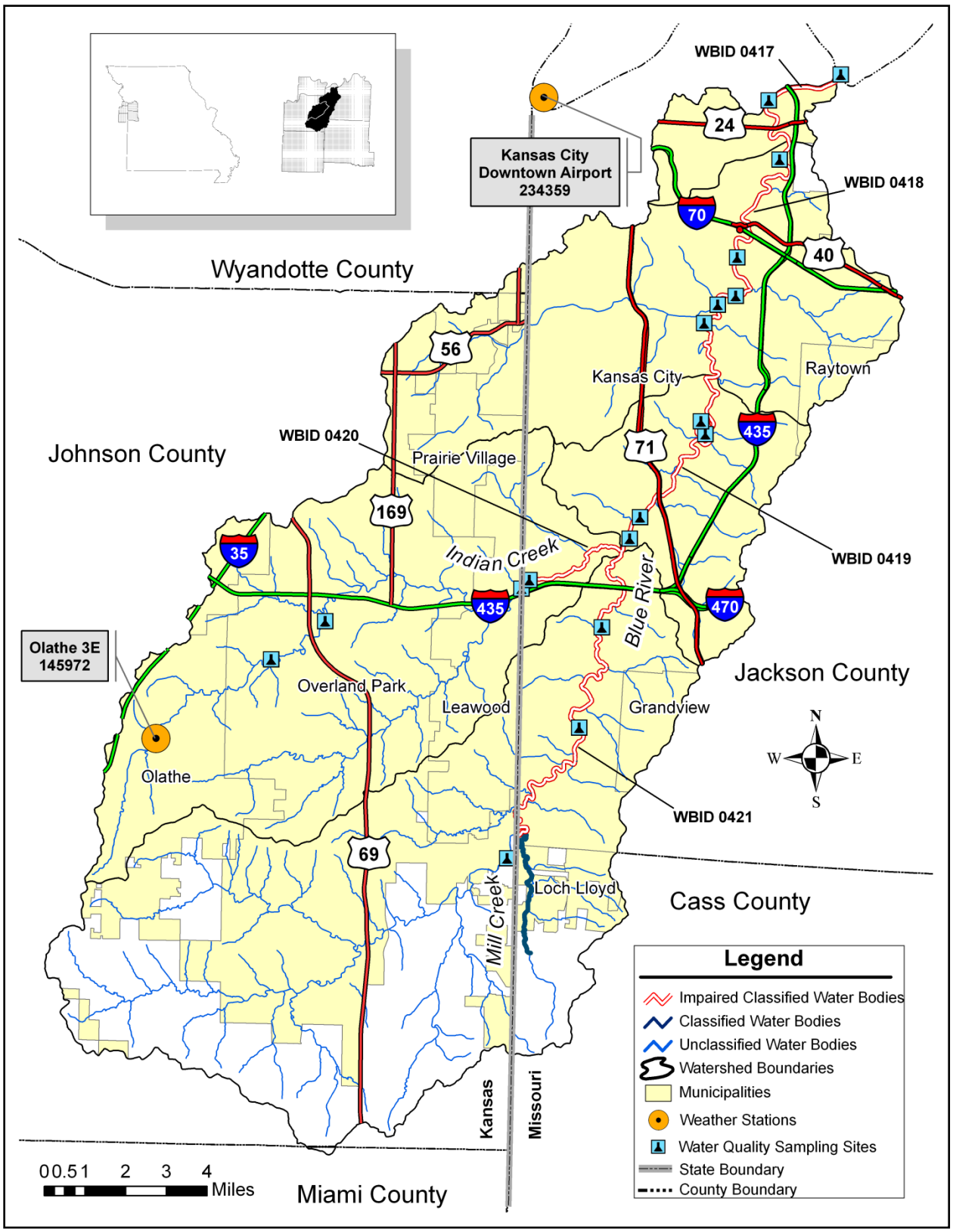


**Figure 1. Blue River and Indian Creek watersheds (with subwatersheds)**

## 2.2 Population

Based on spatial analysis by the Department using 2000 census block data, the Blue River watershed is estimated to have a population of approximately 540,537 people (U.S. Census Bureau 2000 and 2001a). The population is split roughly equally between Missouri and Kansas, with about 268,428 people in the Missouri portion of the watershed, and a population of 272,109 in Kansas. This estimation was completed by using geographic information system software and superimposing the watershed boundary over a map of census blocks containing population data. Whenever the centroid of a census block fell within the watershed boundary, its total population was included in the total. If the centroid of the census block was outside the watershed boundary, then the population was excluded.

The overall population in the Blue River watershed is predominantly urban, and this urban population can be estimated using a method similar to the one used for the entire watershed. Again using 2000 census block data, the estimation is derived by totaling the population for census blocks having centroids within the municipal areas located within the watershed. This method results in an estimated urban population of approximately 532,619 people, once again split about equally between Missouri and Kansas. The non-urban population of the watershed can also be estimated by subtracting the urban population from the total watershed population. This results in an estimated non-urban population in the watershed of approximately 7,918 people.

The Indian Creek watershed, with a population of 216,677, is entirely urban and accounts for about 40 percent of the total population of the Blue River watershed. See Table 1 for a complete breakdown of population in the Blue River and Indian Creek watersheds.

**Table 1. Population in the Blue River and Indian Creek watersheds (U.S. Census Bureau 2000 and 2001a)**

| | Blue River | | | | | Indian Creek | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Urban** | **Non-urban** | **Total** | **Percent Urban** | **Percent Non-urban** | **Urban** | **Non-urban** | **Total** | **Percent Urban** | **Percent Non-urban** |
| **Missouri** | 267384 | 1044 | 268428 | 99.6 | 0.4 | 18752 | 0 | 18752 | 100 | 0 |
| **Kansas** | 265235 | 6874 | 272109 | 97.5 | 2.5 | 197925 | 0 | 197925 | 100 | 0 |
| **TOTAL** | 532619 | 7918 | 540537 | 98.5 | 1.5 | 216677 | 0 | 216677 | 100 | 0 |
| **Percent in Missouri** | 50.2 | 13.2 | 49.7 | | | 8.7 | -- | 8.7 | | |
| **Percent in Kansas** | 49.8 | 86.8 | 50.3 | | | 91.3 | -- | 91.3 | | |

EPA completed a similar analysis using 2000 census data and 12-digit hydrologic unit code watershed boundaries and determined that the Blue River and Indian Creek watersheds in

Missouri are Priority 1 Environmental Justice watersheds.[4] This means that these watersheds are in a category defined as having the greatest proportion of total area determined by the agency to be Environmental Justice areas. Environmental Justice areas are determined by the percentage of minorities and/or the percentage of the population below the poverty level in the 2000 U.S. Census. Environmental Justice watersheds are determined using this information along with the total watershed area and total population (EPA 2011a and Steve Schaff, EPA, e-mail communication, June 30, 2011). Environmental Justice communities may qualify for financial and strategic assistance for addressing environmental and public health issues (EPA 2011b).

## 2.3 Geology, Physiography and Soils

Blue River and Indian Creek are located the Central Plains/Blackwater/Lamine Ecological Drainage Unit[5], or EDU, in the Central Plains aquatic subregion[6]. The Blue River watershed includes pieces of four distinct level IV ecoregions. A small portion of the downstream end of Blue River flows through the Rolling Loess Prairie ecoregion before joining the Missouri River in the Missouri Alluvial Plain. The Wooded Osage Plains ecoregion dominates the majority of the watershed in Missouri and into Kansas. This region is characterized by non-glaciated, gently rolling upland prairie broken by low limestone escarpments and wide stream valleys. Presettlement vegetation was a mixture of oak-hickory woodlands and bluestem prairie, with a greater concentration of woodlands than in more western regions. The Osage Cuestas ecoregion dominates the western portion of the watershed and offers somewhat more topographic relief. Potential natural vegetation in the Blue River area of this region is primarily a mixture of tallgrass prairie and oak-hickory woodlands. Overall topography ranges from flat, in the river valleys, to gently rolling plains in the uplands. The glaciated Loess Prairie and Alluvial Plain regions are characterized by loess and clay loam till over Pennsylvanian and Cretaceous shale, sandstone and limestone. The Osage Cuestas and Wooded Osage Plains regions are unglaciated and dominated by clayey residuum overlaying Pennsylvanian-age bedrock, with alternating deposits of sandstone, shale and limestone. (Chapman, *et al*. 2001 and Chapman, *et al*. 2002).

Spatial analysis conducted by the Department indicates that there are approximately 76 individual soil types represented within the Blue River watershed. Soils in the watershed consist chiefly of silt loams and silty clay loams, and greater than a third of the watershed is identified as being in one or another category of urban land complex (NRCS 2009 and 2010). These urban land complexes are generally described as consisting of 60-70 percent urban land – covered by impervious surfaces – with most of the remainder identified by soil type. The majority of soils associated with the urban land complexes in this watershed are also silt loams or silty clay loams (SCS 1984).

[4] EPA defines Environmental Justice as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations and policies.

[5] Ecological Drainage Units are groups of watersheds having generally similar biota, geography, and climatic characteristics (USGS 2009).

[6] Missouri's three aquatic subregions are the Central Plains, the Mississippi Alluvial Basin, and the Ozark (Sowa, et al. 2005).

Table 2 provides a summary of hydrologic soil groups in the Blue River and Indian Creek watershed, and Figure 2 shows the location and distribution of these soil groups throughout the watershed. Hydrologic soil groups categorize soils by their runoff potential. A soil's hydrologic soil group relates to the rate at which water enters the soil profile, which in turn affects the potential amount of water entering the stream as runoff. Group A represents soils with the highest rate of infiltration (lowest runoff potential) and group D represents soils with the lowest rate of infiltration (highest runoff potential). The dominant hydrologic soil groups in the Blue River watershed, and in each of the subwatersheds, including Indian Creek, are Groups B and C. These two groups are roughly equal in proportion, and together account for over 80 percent of the soils in these watersheds. Soils in the Group B category have a moderately low runoff potential (higher rate of infiltration) and are dominated by loamy sand or sandy loam textures, often with some component of silt or silt loam. Soils in the Group C category have a moderately high runoff potential (lower rate of infiltration). These also typically have a loamy or silt loam texture, but with a higher component of clay than the Group B soils. What is characteristic of both of these hydrologic soil groups that dominate the Blue River watershed is that their runoff potentials are relatively moderate – neither excessively high nor excessively low (NRCS 2007). It should also be remembered, however, that a significant portion of the soils in the watershed have been covered by impervious surfaces, or have otherwise been impacted or disturbed by urbanization. What this means is that runoff in the watershed, to the extent that it impacts water quality, may more likely be a function of human disturbance and urbanization than a function of natural soil conditions.

**Table 2. Hydrologic soil groups in the Blue River and Indian Creek watersheds (NRCS 2009 and 2010)**

| Hydrologic Soil Group | Group A | Group B | Group C | Group C/D | Group D | Not Rated |
|---|---|---|---|---|---|---|
| **WBID 0417** | | | | | | |
| **Square Miles** | 1.35 | 114 | 109.9 | 1.3 | 41.3 | 2.6 |
| **Percentage** | 0.5% | 42.1% | 40.6% | 0.5% | 15.3% | 1.0% |
| **WBID 0418** | | | | | | |
| **Square Miles** | 1.3 | 111.7 | 109.6 | 1.2 | 36.9 | 2.5 |
| **Percentage** | 0.5% | 42.4% | 41.6% | 0.5% | 14.0% | 1.0% |
| **WBID 0419** | | | | | | |
| **Square Miles** | 0.8 | 86.9 | 85.8 | 1.1 | 30.5 | 1.8 |
| **Percentage** | 0.4% | 42.0% | 41.4% | 0.5% | 14.8% | 0.9% |
| **WBID 0420** | | | | | | |
| **Square Miles** | 0 | 32.4 | 31.6 | 0.2 | 10.1 | 0.4 |
| **Percentage** | 0% | 43.4% | 42.2% | 0.3% | 13.5% | 0.6% |
| **WBID 0421** | | | | | | |
| **Square Miles** | 0 | 44.3 | 43.7 | 0.7 | 19.4 | 0.8 |
| **Percentage** | 0% | 40.7% | 40.2% | 0.6% | 17.8% | 0.7% |

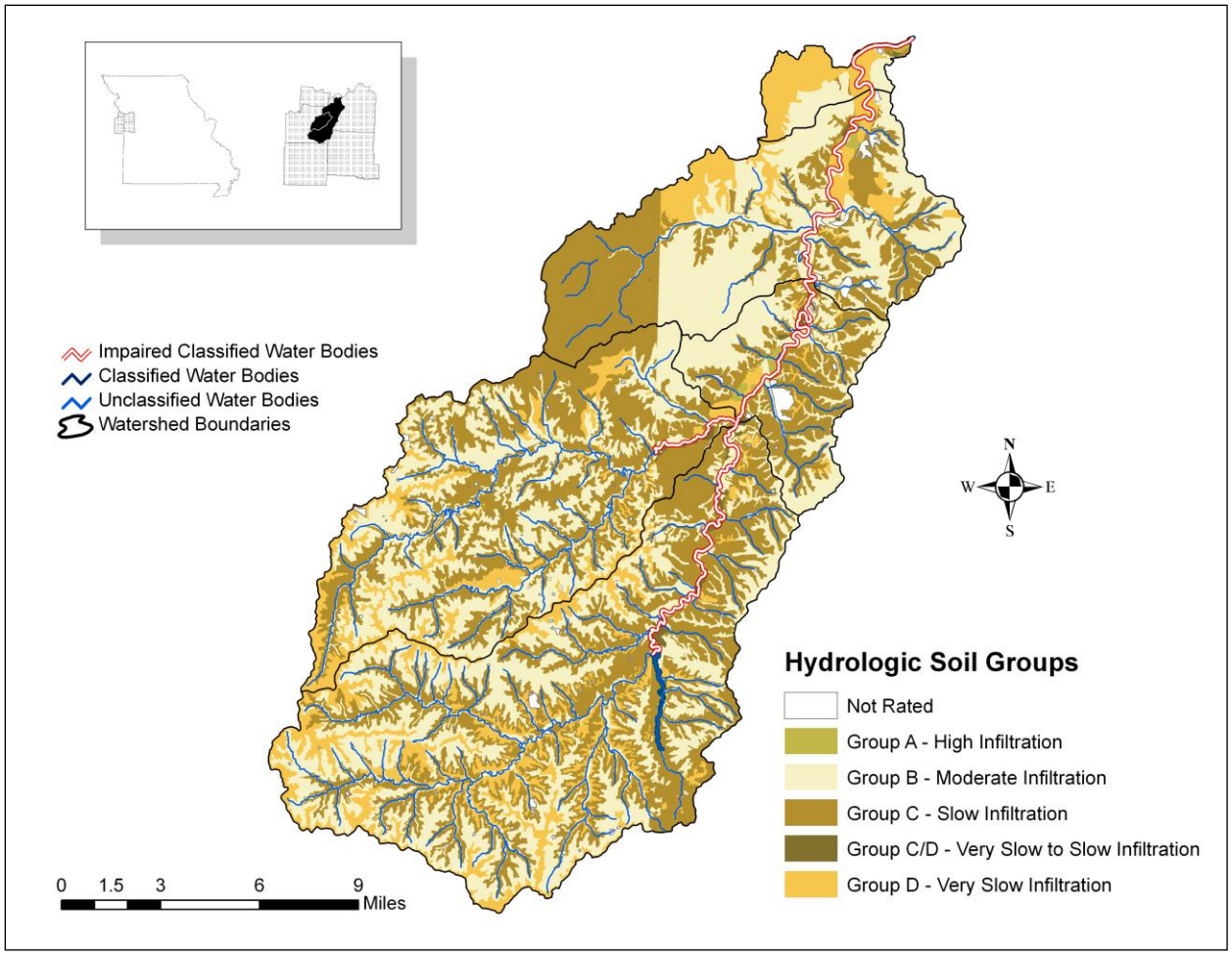


**Figure 2. Hydrologic soil groups in the Blue River and Indian Creek watersheds (NRCS 2009 and 2010)**

## 2.4 Rainfall and Climate

Weather stations provide useful information for developing a general understanding of climatic conditions in the watershed. The Olathe weather station and the Kansas City Downtown Airport weather station are the closest sources to the Blue River and Indian Creek watersheds with recent and available weather and climate data, and are representative of weather conditions in the watersheds. The Olathe station is located in the southern half of the Blue River watershed, within the Indian Creek subwatershed in Johnson County, Kan. (Figure 1). The Kansas City Downtown Airport station is located just outside of the northern tip of the watershed in Clay County, Mo., approximately 5 miles west of the Blue River. Both stations record daily precipitation, daily maximum and minimum temperatures, snowfall and snow depth. Figure 3 provides a summary of precipitation and climate data for the Olathe and Kansas City stations based on 30-year totals (1981–2010) (NOAA 2011). The annual average precipitation and the average daily minimum and maximum temperatures over the 30-year period are 41.43 inches and 45.6/65.2 degrees Fahrenheit (°F) for the Olathe station. The annual average precipitation and the average daily minimum and maximum temperatures are 38.49 inches and 47.5/65.9°F for the

Kansas City station. Precipitation is one important factor related to stream flow and storm water runoff events that can be associated with nonpoint source pollutants. In the case of Blue River, precipitation events can also contribute to sanitary sewer overflows and combined sewer overflows. Other factors contributing to stream flow and stormwater runoff include temperature, rates of evapotranspiration, antecedent soil moisture and the extent of impervious surfaces in the watershed.

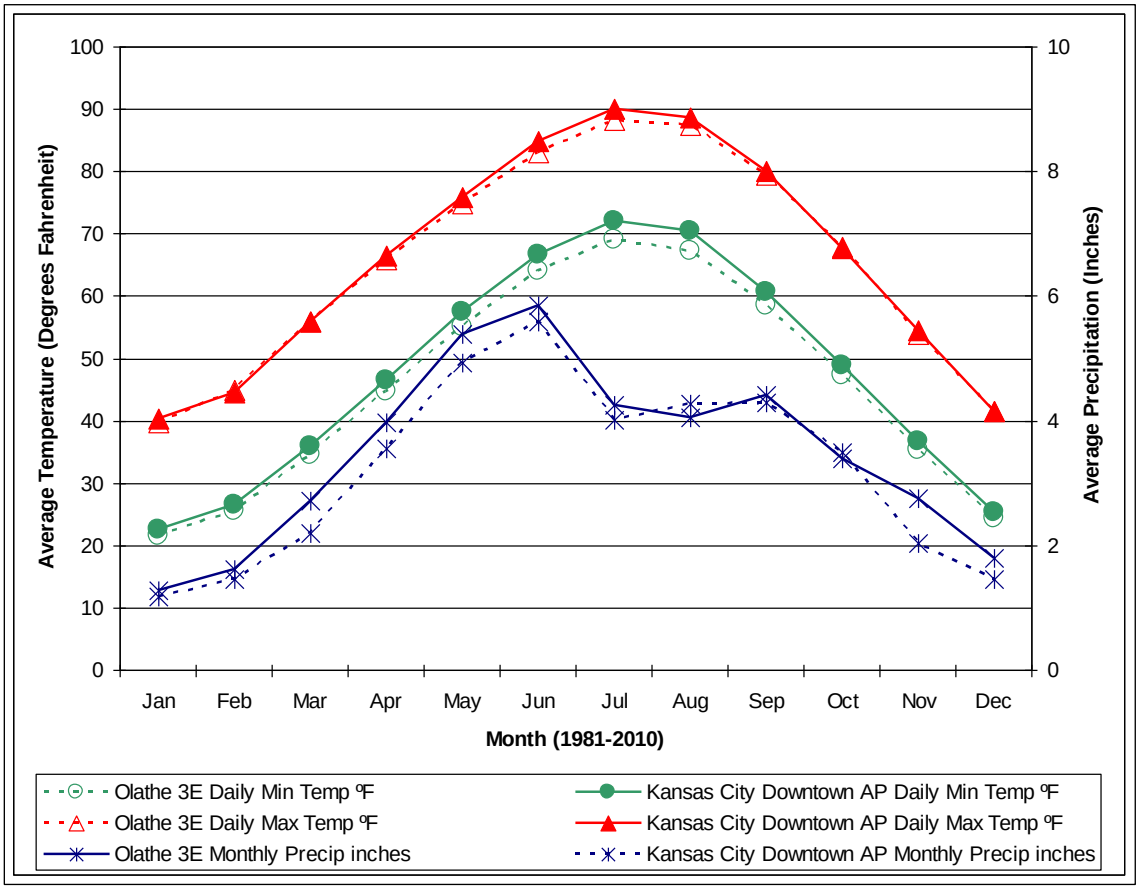


**Figure 3. Thirty Year Monthly Temperature and Precipitation Averages for Olathe 3E and Kansas City Downtown Airport Weather Stations**

## 2.5 Land Use and Land Cover

The land use and land cover of the Blue River watershed is summarized by state, as well as for the entire watershed, for each of the impaired segments. Table 3 through 6 summarize land use and land cover for the watersheds associated with Blue River classified water body segments 0417, 0418, 0419 and 0421. Table 7 summarizes land use and land cover for the watershed

associated with Indian Creek, classified water body segment 0420[7]. Figure 4 depicts the land use and land cover for each of these watersheds. These watersheds are dominated by Kansas City and the surrounding metropolitan area, and the dominant land uses and land covers for the entire Blue River watershed in Missouri and Kansas (associated with water body segment 0417) are urban (65 percent), grassland (17 percent) and forest and woodland (11 percent), with cropland accounting for nearly 6 percent of the watershed. The dominant land uses and land covers for the entire Indian Creek watershed are urban (98 percent), grassland (0.8 percent) and forest and woodland (0.8 percent), with cropland accounting for only 0.3 percent of the watershed. These categories also reflect the dominant land use and land cover in each state. Because of the largely urban nature of these watersheds, particularly in the Indian Creek watershed, areas classified as grassland or forest and woodland may include golf courses, cemeteries, parks, and school playgrounds. Non-urban land uses do appear to exist in the Blue River watershed and are concentrated in the eastern part of the watershed in Missouri, and the southern portion in Kansas.

**Table 3. Land use and land cover in the Blue River watershed (0417) (MoRAP 2005 and KARS 2008).**

| Land Use/ Land Cover | Missouri | | | Kansas | | | Entire Watershed | | |
|---|---|---|---|---|---|---|---|---|---|
| | Watershed Area | | | Watershed Area | | | Watershed Area | | |
| | Acres | Square Miles | Percent | Acres | Square Miles | Percent | Acres | Square Miles | Percent |
| Urban | 45478 | 71.1 | 63.1 | 66839 | 104.4 | 66.1 | 112317 | 175.5 | 64.8 |
| Cropland | 3861 | 6.0 | 5.3 | 5740 | 9.0 | 5.7 | 9602 | 15.0 | 5.5 |
| Grassland | 8124 | 12.7 | 11.3 | 21796 | 34.1 | 21.5 | 29920 | 46.8 | 17.3 |
| Forest/Woodland | 12529 | 19.5 | 17.4 | 6270 | 9.8 | 6.2 | 18799 | 29.4 | 10.9 |
| Open Water | 878 | 1.4 | 1.2 | 406 | 0.6 | 0.4 | 1284 | 2.0 | 0.7 |
| Barren | 54 | 0.1 | 0.1 | 103 | 0.2 | 0.1 | 156 | 0.2 | 0.1 |
| Herbaceous | 286 | 0.4 | 0.4 | ND | ND | ND | 286 | 0.4 | 0.2 |
| Wetland | 868 | 1.4 | 1.2 | ND | ND | ND | 868 | 1.4 | 0.5 |
| **Total** | 72078 | 112.6 | 100 | 101154 | 158.1 | 100 | 173232 | 270.7 | 100 |

Note: MoRAP = Missouri Resource Assessment Partnership
KARS = Kansas Applied Remote Sensing Program
ND = No Data. At the time of this TMDL, data were not available to estimate area of herbaceous and wetland land cover in Kansas.

[7] Note that due to rounding of numbers for presentation purposes in Tables 3 through 7, the sums of the land use categories do not always appear equal to the totals. For the same reason, total watershed areas in these tables do not necessarily equal watershed areas presented in other tables in this document, and they may appear slightly different from those used in development of load duration curves (Section 6).

**Table 4. Land use and land cover in the Blue River watershed (0418)**

| Land Use/ Land Cover | Missouri | | | Kansas | | | Entire Watershed | | |
|---|---|---|---|---|---|---|---|---|---|
| | Watershed Area | | | Watershed Area | | | Watershed Area | | |
| | Acres | Square Miles | Percent | Acres | Square Miles | Percent | Acres | Square Miles | Percent |
| Urban | 41325 | 64.6 | 61.2 | 66839 | 104.4 | 66.1 | 108164 | 169.0 | 64.1 |
| Cropland | 3858 | 6.0 | 5.7 | 5740 | 9.0 | 5.7 | 9598 | 15.0 | 5.7 |
| Grassland | 7945 | 12.4 | 11.7 | 21796 | 34.1 | 21.5 | 29741 | 46.5 | 17.6 |
| Forest/Woodland | 12417 | 19.4 | 18.4 | 6270 | 9.8 | 6.2 | 18687 | 29.2 | 11.1 |
| Open Water | 791 | 1.2 | 1.2 | 406 | 0.6 | 0.4 | 1197 | 1.9 | 0.7 |
| Barren | 54 | 0.1 | 0.1 | 103 | 0.2 | 0.1 | 156 | 0.2 | 0.1 |
| Herbaceous | 286 | 0.4 | 0.4 | ND | ND | ND | 286 | 0.4 | 0.2 |
| Wetland | 857 | 1.3 | 1.3 | ND | ND | ND | 857 | 1.3 | 0.5 |
| **Total** | 67533 | 105.4 | 100 | 101154 | 158.1 | 100 | 168688 | 263.6 | 100 |

**Table 5. Land use and land cover in the Blue River watershed (0419)**

| Land Use/ Land Cover | Missouri | | | Kansas | | | Entire Watershed | | |
|---|---|---|---|---|---|---|---|---|---|
| | Watershed Area | | | Watershed Area | | | Watershed Area | | |
| | Acres | Square Miles | Percent | Acres | Square Miles | Percent | Acres | Square Miles | Percent |
| Urban | 19037 | 29.7 | 48.1 | 58718 | 91.7 | 63.1 | 77755 | 121.5 | 58.7 |
| Cropland | 3717 | 5.8 | 9.4 | 5741 | 9.0 | 6.2 | 9458 | 14.8 | 7.1 |
| Grassland | 6190 | 9.7 | 15.7 | 21791 | 34.0 | 23.4 | 27981 | 43.7 | 21.1 |
| Forest/Woodland | 8991 | 14.0 | 22.7 | 6266 | 9.8 | 6.7 | 15257 | 23.8 | 11.5 |
| Open Water | 596 | 0.9 | 1.5 | 406 | 0.6 | 0.4 | 1002 | 1.6 | 0.8 |
| Barren | 0 | 0.0 | 0.0 | 103 | 0.2 | 0.1 | 103 | 0.2 | 0.1 |
| Herbaceous | 286 | 0.4 | 0.7 | ND | ND | ND | 286 | 0.4 | 0.2 |
| Wetland | 729 | 1.1 | 1.8 | ND | ND | ND | 729 | 1.1 | 0.5 |
| **Total** | 39546 | 61.6 | 100.0 | 93025 | 145.4 | 100 | 132571 | 207.1 | 100 |

**Table 6. Land use and land cover in the Blue River watershed (0421)**

| Land Use/ Land Cover | Missouri | | | Kansas | | | Entire Watershed | | |
|---|---|---|---|---|---|---|---|---|---|
| | Watershed Area | | | Watershed Area | | | Watershed Area | | |
| | Acres | Square Miles | Percent | Acres | Square Miles | Percent | Acres | Square Miles | Percent |
| Urban | 6060 | 9.5 | 29.4 | 15313 | 23.9 | 31.1 | 21374 | 33.4 | 30.6 |
| Cropland | 3297 | 5.2 | 16.0 | 5595 | 8.7 | 11.4 | 8892 | 13.9 | 12.7 |
| Grassland | 4890 | 7.6 | 23.7 | 21530 | 33.6 | 43.8 | 26420 | 41.3 | 37.9 |
| Forest/Woodland | 5085 | 7.9 | 24.7 | 6228 | 9.7 | 12.7 | 11313 | 17.7 | 16.2 |
| Open Water | 446 | 0.7 | 2.2 | 405 | 0.6 | 0.8 | 851 | 1.3 | 1.2 |
| Barren | 0 | 0.0 | 0.0 | 103 | 0.2 | 0.2 | 103 | 0.2 | 0.1 |
| Herbaceous | 286 | 0.4 | 1.4 | ND | ND | ND | 286 | 0.4 | 0.4 |
| Wetland | 557 | 0.9 | 2.7 | ND | ND | ND | 557 | 0.9 | 0.8 |
| **Total** | 20621 | 32.2 | 100.0 | 49174 | 76.8 | 100 | 69795 | 109.1 | 100 |

**Table 7. Land use and land cover in the Indian Creek watershed (0420)**

| Land Use/ Land Cover | Missouri | | | Kansas | | | Entire Watershed | | |
|---|---|---|---|---|---|---|---|---|---|
| | Watershed Area | | | Watershed Area | | | Watershed Area | | |
| | Acres | Square Miles | Percent | Acres | Square Miles | Percent | Acres | Square Miles | Percent |
| Urban | 3498 | 5.4 | 86.5 | 43380 | 67.8 | 98.9 | 46877 | 73.2 | 97.9 |
| Cropland | 23 | 0.0 | 0.6 | 135 | 0.2 | 0.3 | 158 | 0.2 | 0.3 |
| Grassland | 104 | 0.2 | 2.6 | 284 | 0.4 | 0.6 | 388 | 0.6 | 0.8 |
| Forest/Woodland | 324 | 0.5 | 8.0 | 59 | 0.1 | 0.1 | 383 | 0.6 | 0.8 |
| Open Water | 37 | 0.1 | 0.9 | 2 | 0 | 0 | 39 | 0.1 | 0.1 |
| Barren | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Herbaceous | 0 | 0 | 0 | ND | ND | ND | 0 | 0 | 0 |
| Wetland | 55 | 0.1 | 1.4 | ND | ND | ND | 55 | 0.1 | 0.1 |
| **Total** | 4041 | 6.3 | 100 | 43860 | 68.5 | 100 | 47901 | 74.8 | 100 |

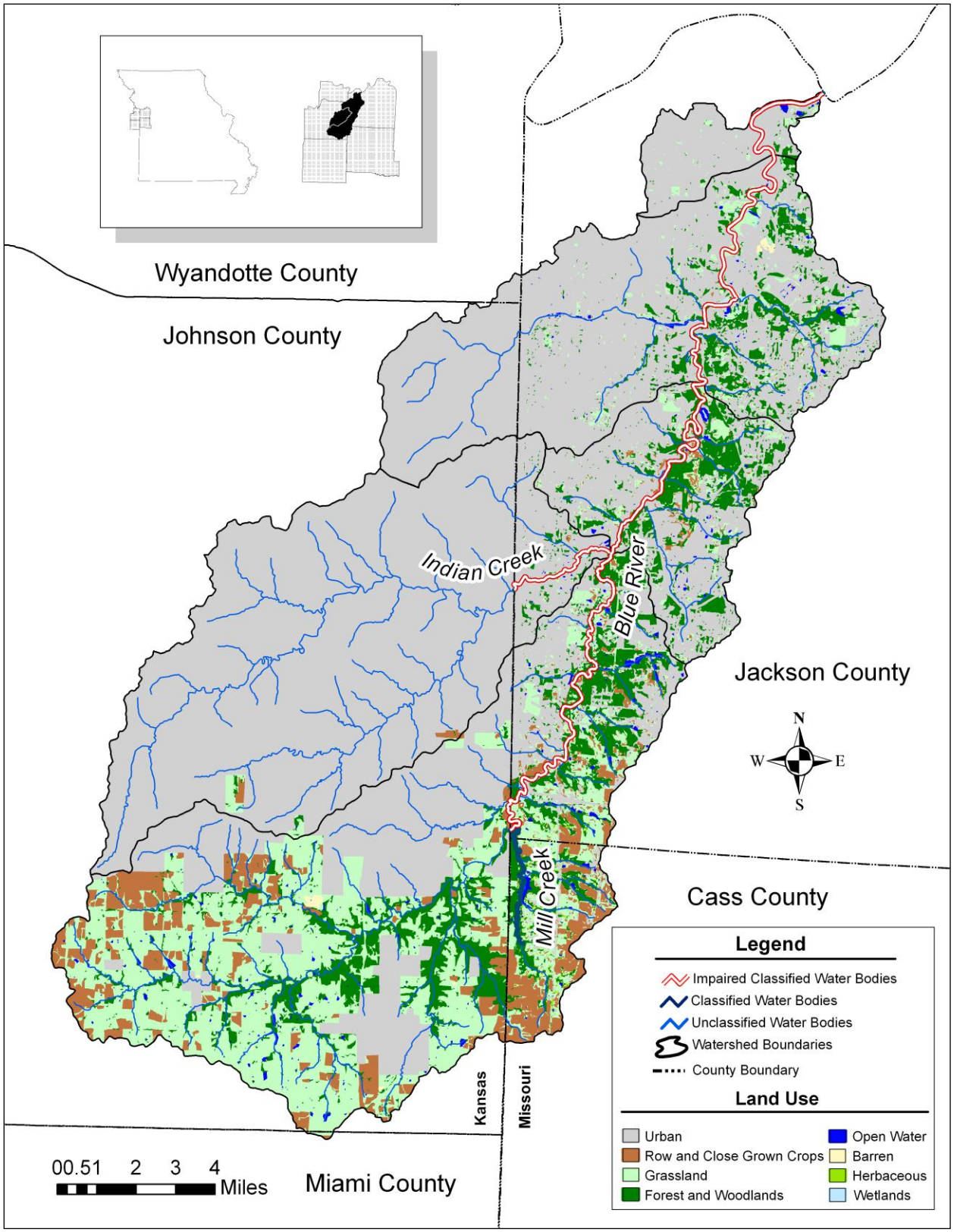


**Figure 4. Land use and land cover in the Blue River and Indian Creek watersheds (MoRAP 2005 and KARS 2008)**

## 2.6 Defining the Problem

Blue River and Indian Creek are listed as impaired by bacteria on Missouri's 2010 303(d) List of impaired waters. This impairment refers to fecal bacteria, which are a concern because excessive amounts of such bacteria in surface water used for recreation are an indication of an increased risk of pathogen-induced illness to humans. Infections due to pathogen-contaminated waters include gastrointestinal, respiratory, eye, ear, nose, throat and skin diseases. *Escherichia coli*, or *E. coli*, are one type of fecal bacteria found in the intestines of warm blooded animals and are used as indicators of the risk of waterborne disease from pathogenic (disease causing) bacteria or viruses (EPA 1997). Most *E. coli* strains are harmless, but some can cause serious illness in humans. The harmless strains are part of the normal flora of the intestines, and can benefit their hosts by preventing the establishment of pathogenic bacteria within the intestine (Hudault et al. 2001 and Reid et al. 2001).

Missouri's Water Quality Standards use *E. coli* as an indicator, and the criteria are based on specific levels of risk of acute gastrointestinal illness that are calculated to be protective of the whole body contact recreation and secondary contact recreation designated uses (Section 4.2). To address these water quality impairments, this TMDL targets instream bacteria levels using *E. coli* as the primary measurement parameter. There are other quantitative indicators of fecal bacteria; however, *E. coli* was selected as the numeric target for bacteria in this TMDL because it is consistent with Missouri's Water Quality Standards, and it enables the use of the most common and accepted sampling methods and techniques and allows the use of the highest-quality data available.

TMDLs are needed for the classified segment of Indian Creek and for the four classified segments of Blue River because these water bodies are not meeting the water quality criteria for *E. coli* bacteria. These impairments were assessed based on water quality samples collected and analyzed by the U.S. Geological Survey, or USGS, the Kansas Department of Health and Environment, or KDHE, and EPA Region 7. These data are of sufficient quality to evaluate compliance with water quality standards and to support TMDL development. The results of these surveys are summarized in Table 8 and displayed in Figure 5. According to the Department's 303(d) listing methodology, at least five water quality samples taken during the recreation season are required to calculate a geometric mean in order to assess impairment based on compliance or exceedance of the *E. coli* criteria. A water body is judged to be impaired if the geometric mean is exceeded in any of the last three years for which adequate data is available. Although a number of the recreational season geometric means do not meet this standard for assessment, they do indicate a frequent exceedance of the bacteria criteria among all five water body segments. A full listing of the data used in the assessment of these impairments is presented in Appendix A.

**Table 8. Blue River and Indian Creek annual recreation season *E. coli* geometric means[a], 1998 – 2010**

| WBID | Year | No. of samples in Recreation Season[b] | Recreation Season Geometric Mean | WBC Criterion[c] | Exceedance[d] |
|---|---|---|---|---|---|
| 0417 | 1998 | 2 | 465 | 206 | --- |
| | 1999 | 4 | 1,081 | | --- |
| | 2000 | 4 | 2,529 | | --- |
| | 2002 | 2 | 297 | | --- |
| | 2004 | 2 | 4,996 | | --- |
| | 2005 | 4 | 732 | | --- |
| 0418 | 1998 | 2 | 354 | 206 | --- |
| | 1999 | 4 | 2,215 | | --- |
| | 2000 | 4 | 892 | | --- |
| | 2003 | 7 | 2,290 | | Yes |
| | 2004 | 3 | 518 | | --- |
| | 2005 | 9 | 2,900 | | Yes |
| | 2006 | 5 | 5,674 | | Yes |
| | 2007 | 3 | 5,213 | | --- |
| | 2010 | 15 | 911 | | Yes |
| 0419 | 1998 | 2 | 162 | 126 | --- |
| | 1999 | 4 | 1,448 | | --- |
| | 2000 | 4 | 356 | | --- |
| | 2001 | 2 | 147 | | --- |
| | 2002 | 2 | 36 | | --- |
| | 2003 | 6 | 1,817 | | Yes |
| | 2004 | 4 | 656 | | --- |
| | 2005 | 12 | 852 | | Yes |
| | 2006 | 5 | 4,182 | | Yes |
| | 2007 | 3 | 4,268 | | --- |
| | 2010 | 15 | 502 | | Yes |
| 0420 | 2002 | 4 | 941 | 126 | --- |
| | 2003 | 8 | 5,777 | | Yes |
| | 2004 | 6 | 456 | | Yes |
| | 2005 | 8 | 256 | | Yes |
| | 2006 | 7 | 1,163 | | Yes |
| | 2007 | 7 | 1,750 | | Yes |
| | 2008 | 3 | 418 | | --- |
| | 2009 | 3 | 333 | | --- |
| | 2010 | 2 | 183 | | --- |
| 0421 | 2001 | 2 | 338 | 206 | --- |
| | 2002 | 2 | 62 | | --- |
| | 2003 | 8 | 3,306 | | Yes |
| | 2004 | 6 | 256 | | Yes |
| | 2005 | 7 | 71 | | No |
| | 2006 | 9 | 1,584 | | Yes |
| | 2007 | 7 | 750 | | Yes |
| | 2008 | 3 | 242 | | --- |
| | 2009 | 3 | 331 | | --- |
| | 2010 | 16 | 1,265 | | Yes |

[a] The units for all geometric mean values are counts of *E. coli* present per 100 milliliters of water.
[b] The recreation season extends from April 1 to October 31 of each year.
[c] WBC refers to whole body contact. The water quality criteria for *E. coli* are a geometric mean of 126 counts/100 mL of water during the recreation season for whole body contact recreation – category A, and a geometric mean of 206 counts/100 mL of water during the recreation season for whole body contact recreation – category B.
[d] Exceedance was not evaluated for recreation seasons with fewer than 5 samples.

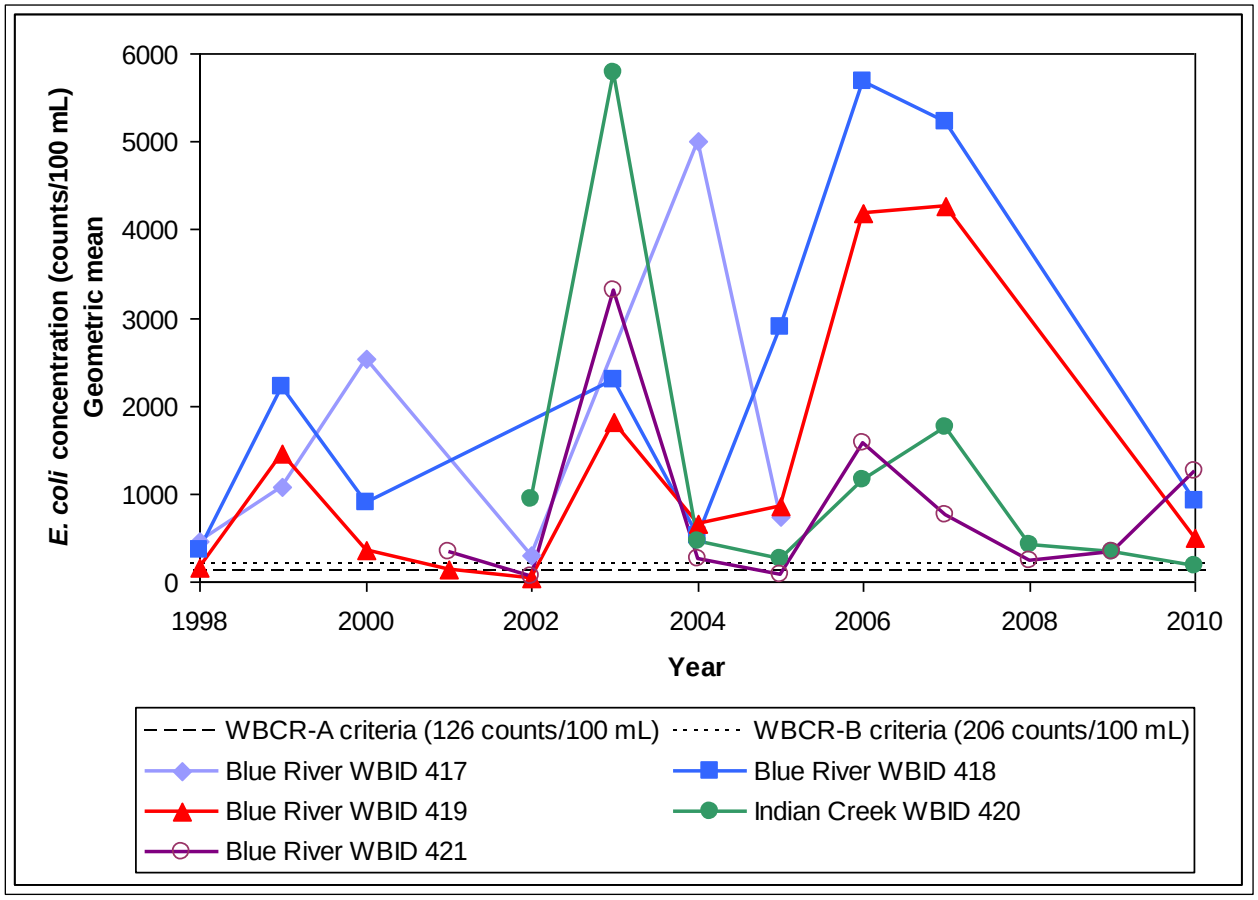


**Figure 5. Blue River and Indian Creek annual recreation season *E. coli* geometric means, 1998 – 2010**

In addition to presenting the bacteria data as recreational season geometric means by year, Figures 6 through 10 below present box plots for each water body depicting the range of bacteria data, by month, for all of the years for which data is available. As noted in the legend of these figures, the centerline of each plot depicts the median data value for that month; the upper and lower bounds of each box represent the 75$^{th}$ and 25$^{th}$ percentile of data, respectively; and the upper and lower bounds of each whisker represent the maximum and minimum data value, respectively.

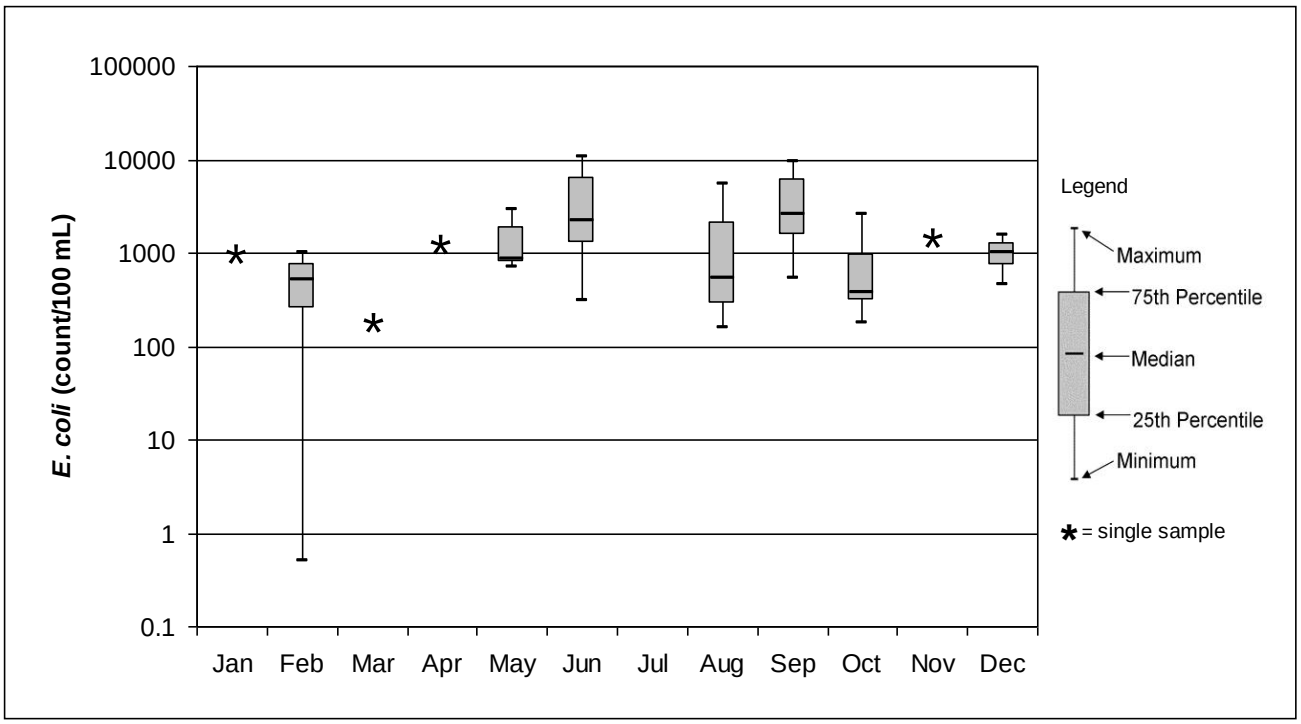


**Figure 6. Monthly *E. coli* data for WBID 0417, 1998-2005**

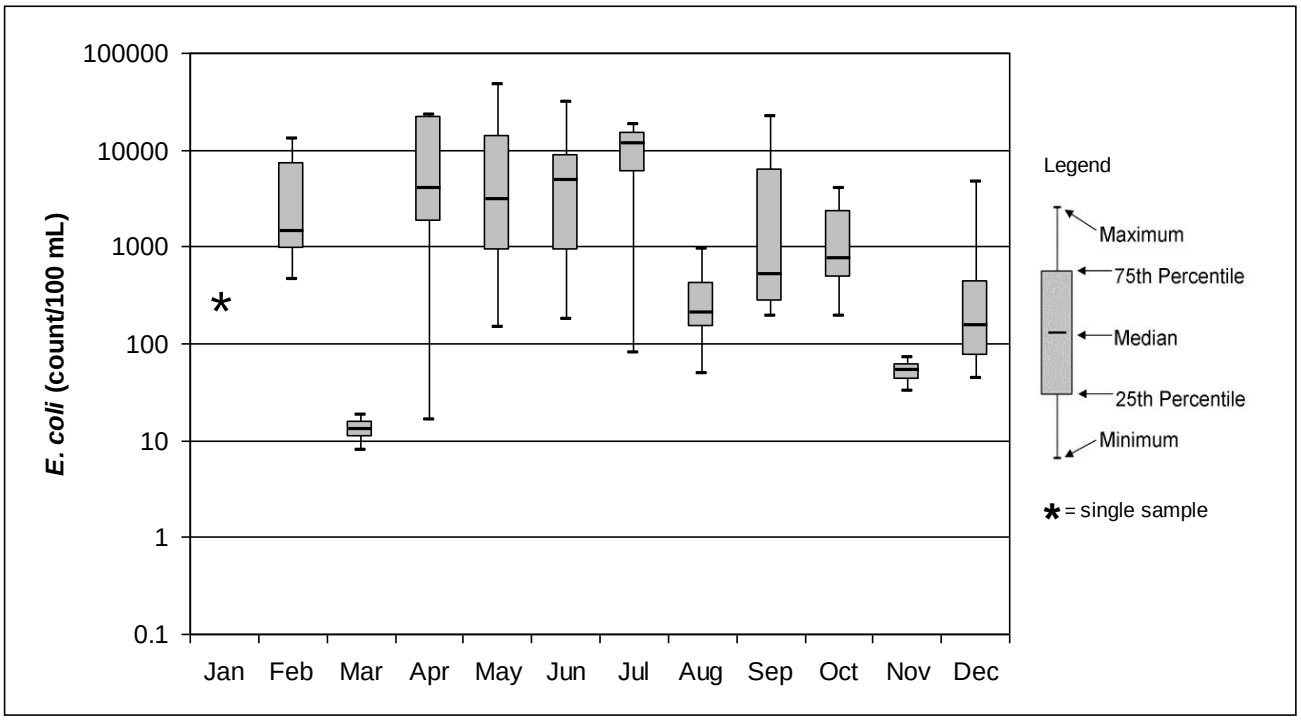


**Figure 7. Monthly *E. coli* data for WBID 0418, 1998-2010**

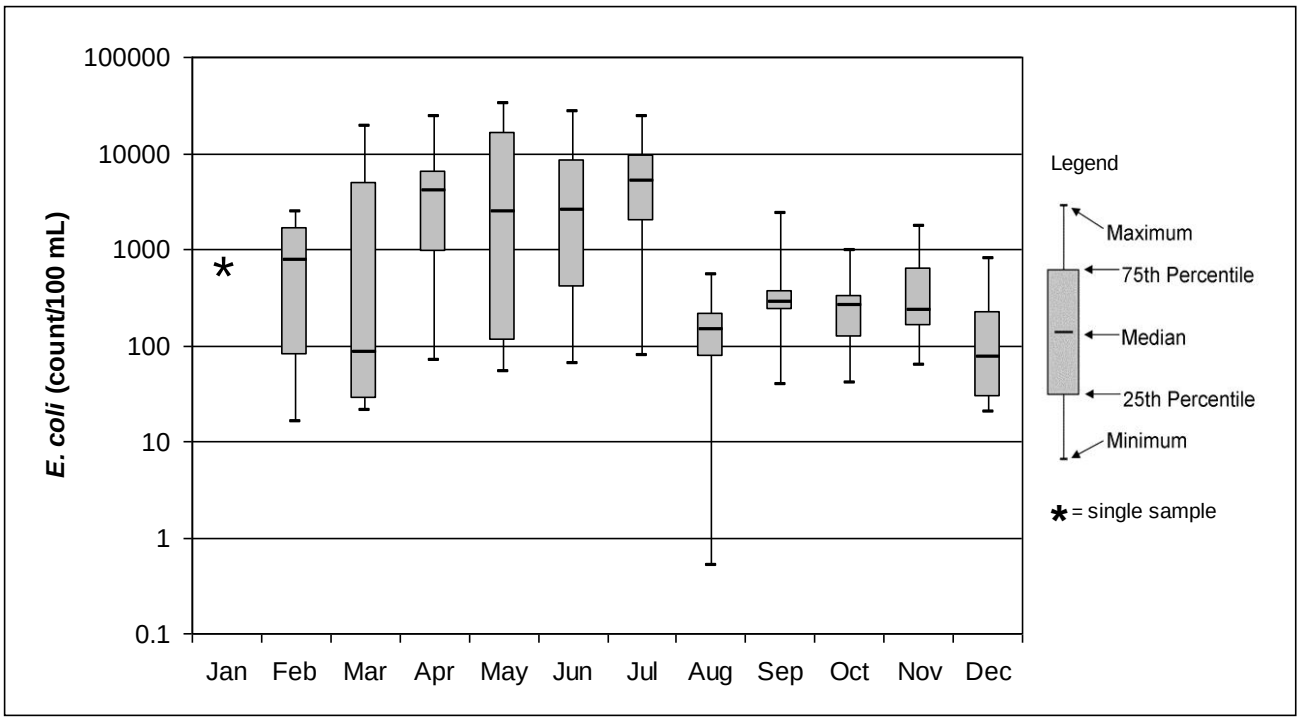


**Figure 8. Monthly *E. coli* data for WBID 0419, 1998-2010**

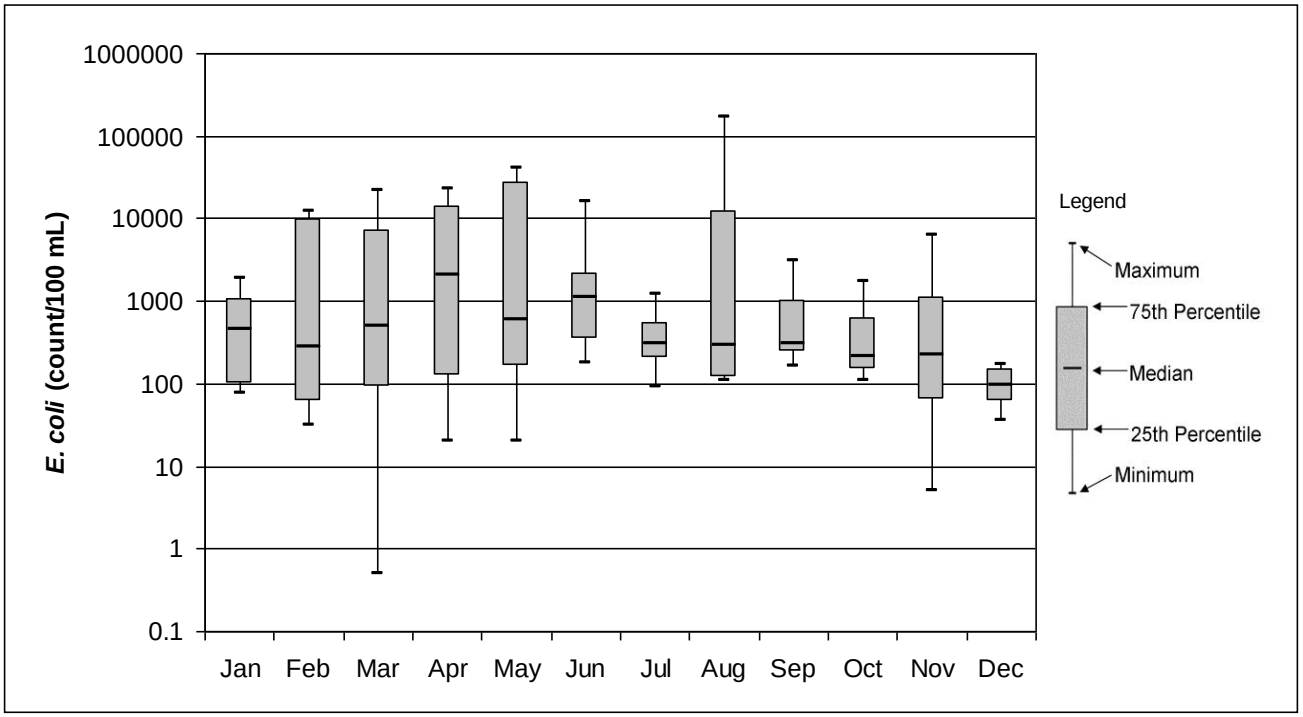


**Figure 9. Monthly *E. coli* data for WBID 0420, 2000-2010**

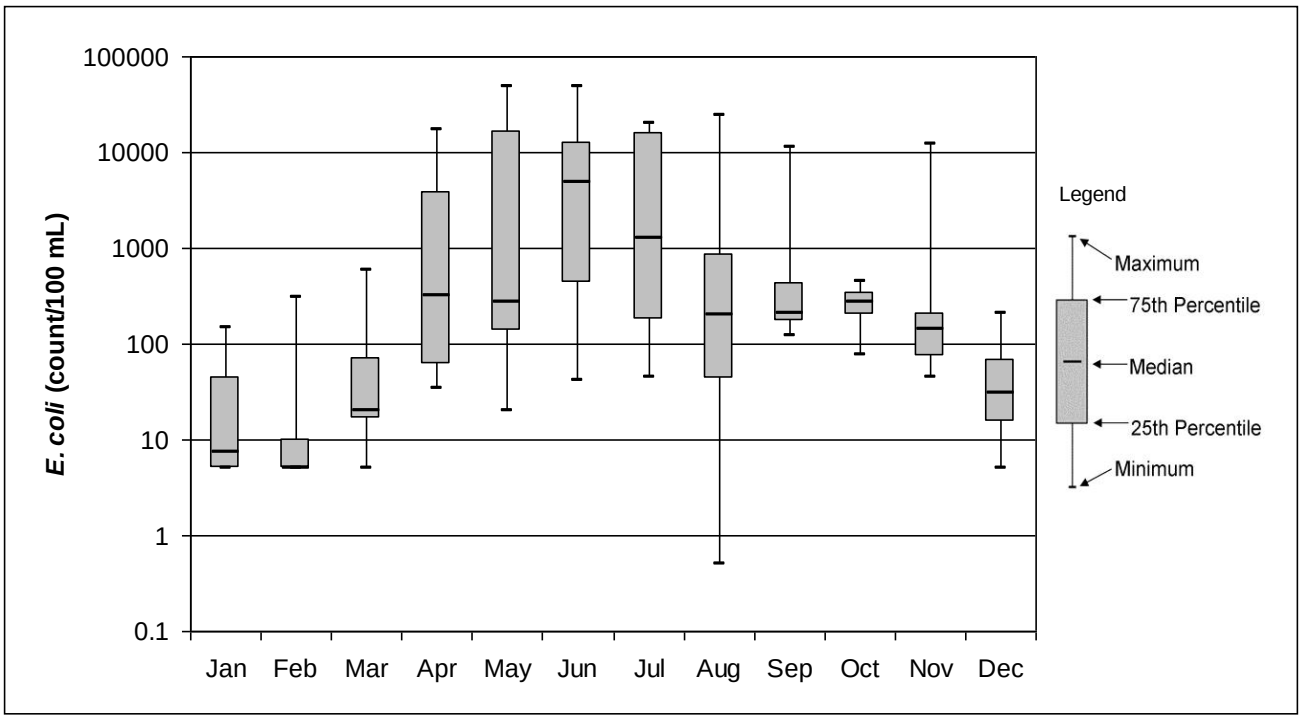


**Figure 10. Monthly *E. coli* data for WBID 0421, 2001-2010**

# 3 Source Inventory and Assessment

The source inventory and assessment characterizes known, suspected and potential sources of pollutant loading to the impaired water body. Pollutant sources identified within the watershed are categorized and quantified to the extent that information is available. Sources of pollutants may be point (regulated) or nonpoint (unregulated) in nature.

## 3.1 Point Sources

Point sources are defined under Section 502(14) of the federal Clean Water Act as any discernible, confined and discrete conveyance, such as a pipe, ditch, channel, tunnel or conduit, by which pollutants are transported to a water body. Point sources in Missouri are regulated through the Missouri State Operating Permit program[8] and include industrial, domestic and municipal wastewater treatment facilities, and combined sewer overflow outfalls. By law, point sources also include concentrated animal feeding operations, or CAFOs, stormwater runoff from construction and industrial sites, illicit straight pipe discharges, and stormwater discharges from municipal separate storm sewer systems; or MS4s. Point sources in Kansas are regulated by the Kansas Department of Health and Environment and are presented in this document for informational purposes. The locations of each outfall for the permitted point sources in both Missouri and Kansas, including land area regulated under MS4 permits, are shown in Figure 11.

[8] The Missouri State Operating Permit program is Missouri's program for administering the federal National Pollutant Discharge Elimination System program.

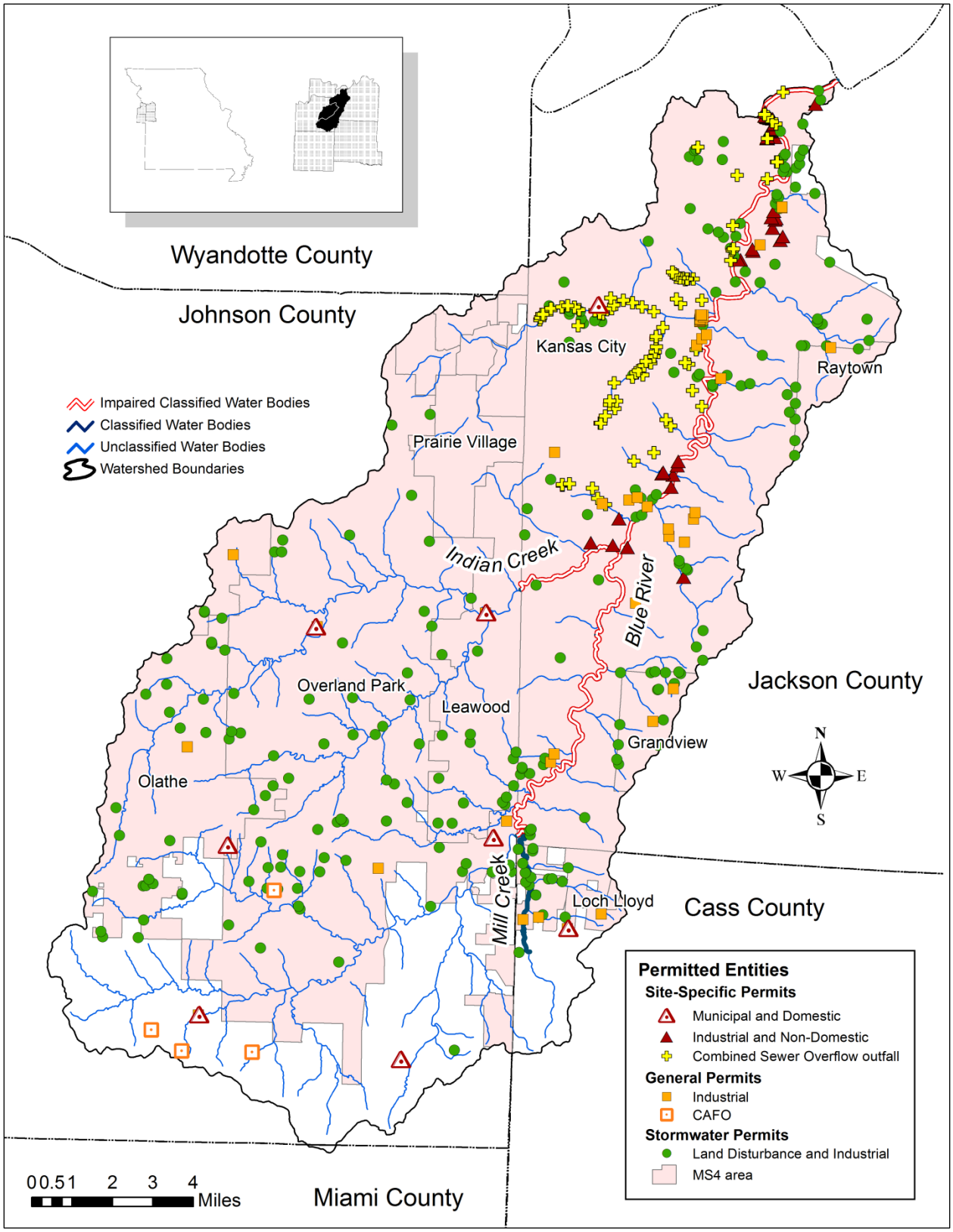


**Figure 11. Permitted point sources in the Blue River and Indian Creek watersheds**

At the time of this writing, the Missouri portion of the Blue River watershed contains 11 permitted entities holding site-specific permits and 119 entities holding general or stormwater permits. The site-specific permitted facilities in the Missouri portion of the Blue River and Indian Creek watersheds are listed in Table 9, and the general and stormwater permits are summarized by category in Table 10. A full list of general and stormwater permits in Missouri can be found in Appendix B. There are no permitted CAFOs in the Missouri side of these watersheds, but there are a number of designated MS4 stormwater permits, and one MS4 site-specific permit. Designated as Metropolitan No-Discharge Streams, no water contaminant except uncontaminated cooling water, permitted stormwater discharges in compliance with permit conditions, and excess wet-weather bypass discharges not interfering with beneficial uses, may be discharged into either the Blue River or Indian Creek watersheds in Missouri.[9] The one exception to this rule is for the allowance of certain discharges from combined sewer overflows into portions of Blue River.

In the Kansas portion of the Blue River watershed there are four permitted livestock facilities, 16 permitted entities holding site-specific permits, including five municipal or domestic wastewater facilities, and 147 entities holding general or stormwater permits. The site-specific permitted facilities in the Kansas portion of the Blue River and Indian Creek watersheds are listed in Table 11, and the livestock facilities are listed in Table 12. A full list of Kansas general and stormwater permits can be found in Appendix B. It should be noted that expiration dates for these permits were not available and some of these permits may no longer be active. The Department assumes that activities associated with permitted facilities in the Kansas side of the watershed are conducted in compliance with all permit conditions, including monitoring and discharge limitations. It is expected that compliance with these permits will result in bacterial loadings at or below applicable targets.

**Table 9. Missouri site-specific permitted facilities in the Blue River and Indian Creek watersheds**

| Permit No. | Facility Name | Receiving Stream | Design Flow (MGD) | Permit Expiration Date |
|---|---|---|---|---|
| MO-0004863 | U.S. Dept. of Energy, Kansas City Plant | Indian Creek and Blue River | 5.38 (Stormwater) | 11/2/2004 |
| MO-0004952 | AK Steel Corporation | Blue River | Stormwater | 2/10/2015 |
| MO-0024911 | Kansas City Blue River WWTP | Missouri River | 105[10] | 11/15/2016 |
| MO-0111180 | Sanofi-Aventis | Tributary to Blue River | 429.8 (Stormwater) | 8/20/2014 |
| MO-0115801 | Advantage Metals Recycling, LLC | Ditch to Blue River | Stormwater | 05/19/2016 |
| MO-0117692 | Waste Express, Inc. | Tributary to Blue River | Stormwater | 6/1/2011 |

[9] 10 CSR 20-7.031(6) and Table F
[10] Entire design flow discharges to the Missouri River

| Permit No. | Facility Name | Receiving Stream | Design Flow (MGD) | Permit Expiration Date |
|---|---|---|---|---|
| MO-0118214 | Sneads Bar-B-Q | Tributary to Mill Creek | 0.0016 | 12/22/2014 |
| MO-0120294 | Former Koppers Facility | Tributary to Blue River | 120 (Stormwater) | 10/22/2014 |
| MO-0123790 | Centropolis Landfill | Tributary to Blue River | 4.66 (Stormwater) | 8/13/2014 |
| MO-0127787 | MDC Discovery Center | Brush Creek | 0.0024 | 10/11/2012 |
| MO-0130516 | Kansas City MS4 | Tributary to Blue River | Stormwater | 9/2/2009 |

**Table 10. Categories of Missouri general and stormwater permits in the Blue River and Indian Creek watersheds[11]**

| Permit # | Description | Total |
|---|---|---|
| MO-G49xx | Limestone Quarries | 17 |
| MO-G69xx | Dredging Lakes/Rivers Harbors | 1 |
| MO-G76xx | Swimming Pool Discharges | 1 |
| MO-G97xx | Yard Waste Compost Sites | 3 |
| MO-R04xx | Small MS4s | 3 |
| MO-R104xx | Land Disturbance > 5 Acres | 1 |
| MO-R105xx | Land Disturbance > 5 Acres | 2 |
| MO-R109xx | Land Disturbance in Designated Acres | 6 |
| MO-R10xx | Land Disturbance > 1 Acre | 33 |
| MO-R13xx | Textile and Apparel/Printing and Publishing | 3 |
| MO-R203 | Fabricated Metal, Light Industrial | 8 |
| MO-R23D | Plastics and Rubber Manufacturing | 2 |
| MO-R60A | Motor Vehicle Salvage | 17 |
| MO-R80C | Motor Freight Transportation | 5 |
| MO-R80H | Solid Waste Transfer | 2 |
| MO-RA | Construction or Land Disturbance | 15 |
| | Total | 119 |

[11] Descriptions of general and stormwater permit categories can be found on the Department's website at: http://dnr.mo.gov/env/wpp/permits/index.html

**Table 11. Kansas site-specific permitted facilities in the Blue River and Indian Creek watersheds**

| Permit No. | Facility Name | Receiving Stream | Design Flow (MGD) | Permit Expiration Date |
|---|---|---|---|---|
| I-MO26-PO03 | Stanley West Quarry | Tributary to Coffee Creek | Stormwater | 10/31/2013 |
| I-MO26-PO03 | East Stanley Site | Tributary to Blue River | Stormwater | 3/31/2012 |
| I-MO28-PR01 | Clarkson Construction – Plant Rex 6209 | Indian Creek | Stormwater | 9/30/2012 |
| M-MO14-NO05 | Johnson County Executive Airport | NA | No Discharge | 10/31/2014 |
| M-MO14-OO03 | Timber Wolf Estates WWTP | Tributary to Wolf Creek | 0.019 | 3/31/2013 |
| M-MO26-OO03 | Stilwell Elementary School WWTP | Camp Branch | 0.035 | 6/30/2013 |
| M-MO26-OO06 | Blue River Main Sewer District No. 1 | Negro Creek | 10.5 | 12/31/2011 |
| M-MO27-OO01 | Tomahawk Creek M.S.D. No. 1 WWTP | Indian Creek | 10 | 12/31/2009 |
| M-MO28-OO01 | Johnson County Smith Middle Basin WWTP | Indian Creek | 12 | 12/31/2009 |
| M-MO27-SU01 | City of Leawood MS4 | Unknown | Stormwater | 9/30/2009 |
| M-MO28-SU01 | City of Overland Park MS4 | Unknown | Stormwater | 9/30/2009 |
| M-MO34-SU01 | City of Fairway MS4 | Unknown | Stormwater | 9/30/2009 |
| M-MO35-SU01 | City of Roeland Park MS4 | Unknown | Stormwater | 9/30/2009 |
| M-MO36-SU01 | City of Westwood MS4 | Unknown | Stormwater | 9/30/2009 |
| M-MO37-SU01 | City of Mission Hills MS4 | Unknown | Stormwater | 9/30/2009 |
| M-MO38-SU01 | City of Prairie Village MS4 | Unknown | Stormwater | 9/30/2009 |

**Table 12. Kansas livestock facilities in the Blue River and Indian Creek watersheds**

| *Active Livestock Permits* | | |
|---|---|---|
| **Permit Number** | **Type** | **Animal Units**[12] |
| A-MOJO-L001 | Sheep/horses | 242 |
| *Active Livestock Certificates* | | |
| **Certificate Number** | **Type** | **Animal Units** |
| A-MCJO-BA10 | Beef | 290 |
| A-MOJO-BA01 | Beef | 412.5 |
| A-MOJO-MA03 | Dairy | 98 |

[12] As defined in Kansas statute KSA 65-171d(c)(3).

### 3.1.1 Municipal and Domestic Wastewater Permits

Municipal and domestic wastewater treatment facilities are designed to treat household waste, including both gray water and sewage. These treatment facilities can be potential sources of bacteria, particularly when malfunctions, vandalism, mismanagement, or excessive storm flows cause untreated sewage to discharge into a receiving water body. There are only two domestic wastewater treatment facilities that discharge within the Missouri portion of the Blue River watershed. One is a lagoon system associated with Sneads Bar-B-Q (MO-0118214) that discharges to a tributary to Blue River. It is a very small system with a very low design flow and, as such, it is not expected to be a significant contributor of bacteria to the watershed. The other domestic facility, the Missouri Department of Conservation Discovery Center (MO-0127787), treats a portion of its wastewater onsite with a wetland system, and discharges the rest to the Kansas City, Mo. municipal wastewater treatment system. As a result, the Discovery Center is not expected to be a source of bacteria to Blue River or any of its tributaries.

The sole municipal wastewater treatment plant affecting the Missouri side of the Blue River watershed is the Kansas City Blue River Wastewater Treatment Facility. This facility is one of seven such facilities operated by the Kansas City Water Services Department, and is the city's largest, with a maximum permitted design flow of 105 million gallons per day. Treated effluent from this facility is not discharged to the Blue River, but is instead discharged through a primary outfall directly to the Missouri River. Although the treatment facility is located outside of the Blue River watershed and discharges outside of the watershed, this facility and the urban area within the watershed includes areas serviced by a separate sanitary sewer system, as well as areas serviced by a combined sewer system. In addition to serving residents and businesses within the corporate city limits, the separate sanitary sewer system also serves a number of satellite communities, most significantly the Johnson County, Kan. Wastewater District, with a population of approximately 127,000 people.

A sanitary sewer system is a municipal wastewater collection system designed to convey domestic, commercial and industrial wastewater to a municipal wastewater treatment facility. This system can include limited amounts of inflow and infiltration from groundwater and storm water, but it is not designed to collect large amounts of runoff from precipitation events. Untreated or partially treated discharge from a sanitary sewer system is generally referred to as a sanitary sewer overflow, and can include overflows out of manholes, or backups into private residences. Such discharges are unpermitted and are not authorized by the federal Clean Water Act. They can occur as a result of vandalism, power failures, lapses in sewer system operation and maintenance, or excessive inflow and infiltration. It is estimated that about half of the annual flow within the Kansas City sewer system is attributable to inflow and infiltration during wet weather events, and that peak flows during heavy rainfall can be up to ten times the average daily flow during dry weather (Kansas City 2009). While there no constructed sanitary sewer overflows within the Blue River watershed, unintended discharges do occur and can result in elevated bacteria concentrations to the receiving streams. One such occurrence of an accidental overflow, attributed to a debris blockage, occurred on April 13, 2011 and resulted in an estimated discharge of 1 gallon per minute into an unnamed tributary to Blue River (Kansas City Infozine 2011). In addition, it is estimated that within two Blue River subbasins that were studied as part of Kansas City's Overflow Control Plan, a 5-year, 24-hour rainfall event may result in a

discharge of almost 69 million gallons of untreated wastewater and stormwater from sanitary sewer overflows (Kansas City 2009). For this reason, sanitary sewer overflows are considered to be potentially significant contributors of *E. coli* to Blue River and Indian Creek.

The other type of sewer system in the Blue River watershed is a combined sewer system. Combined sewer systems are designed to collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipe and transport it to a wastewater treatment plant, where it is treated and then discharged. During periods of heavy precipitation, however, the wastewater volume in a combined sewer system can exceed the capacity of the sewer system or treatment plant. For this reason, combined sewer systems are designed to overflow occasionally and discharge excess wastewater directly to nearby streams or rivers. These discharges, called combined sewer overflows, contain not only stormwater runoff but also untreated human and industrial waste, including potentially high levels of bacteria. There are approximately 87 identified combined sewer outfalls in the Missouri side of the Blue River watershed (Figure 11 and Appendix C) with a total estimated annual overflow volume of 2.8 billion gallons, and an average overflow frequency of at least 18 times per year per combined sewer outfall (Kansas City 2009). For this reason, combined sewer overflows are considered to be potentially significant contributors of *E. coli* to Blue River. There are no combined sewer outfalls in the Indian Creek subwatershed.

Like all wastewater treatment plants in Missouri, the Kansas City Blue River Wastewater Treatment Facility must meet the requirements of an operating permit issued by the Department. This permit contains discharge limits that this facility must meet to be protective of in-stream water quality standards. Previous operating permits in Missouri authorized discharges of bypassed wastewater at some facilities during peak flow conditions. These facility discharges from treatment plant outfalls (not to be confused with combined sewer overflows) were required to meet effluent limitations, but these limitations were not as stringent as those for the main facility discharge. Changes to Department regulations have removed this authorization, and permits are now issued without bypass discharges being authorized. Discharges resulting from emergency diversion shall be considered an unauthorized bypass pursuant to 40 CFR 122.41(m) and shall be reported, pursuant to 40 CFR 122.41(m)(3)(ii).

The current site-specific operating permit for the Kansas City Blue River Wastewater Treatment Facility was renewed on Nov. 16, 2011 and expires on Nov. 15, 2016. In addition to revising effluent limits for the main facility outfall, including establishing *E. coli* limits, the new permit includes a number of other significant changes, some of which are driven by the consent decree settlement and the establishment of the city's Overflow Control Plan. These changes include, among other things, a mandate that the permittee shall develop and implement a Storm Water Pollution Prevention Plan, as well as develop and implement a program for the maintenance and repair of the collection system to address both sanitary and combined sewer overflows. The revised permit also includes the Department's approval of Kansas City's development of a Sewer Extension Authority, as well as an acknowledgement of the city's Overflow Control Plan for the control of combined sewer overflows. This acknowledgement is coupled with a requirement that the permittee shall submit an annual report to the Department on the previous year's effort's to implement the Plan.

### 3.1.2 Industrial and Non-Domestic Wastewater Permits

There are no facilities in the Blue River and Indian Creek watersheds discharging industrial and non-domestic wastewater. Industrial and non-domestic facilities within these watersheds are permitted to discharge only stormwater. For these reasons, industrial and non-domestic facilities are not expected to cause or significantly contribute to the bacteria impairment of either Blue River or Indian Creek.

### 3.1.3 Municipal Separate Storm Sewer System Permits

As noted in Tables 9 – 11, as well as Appendix B, there are a number of MS4 permits in the Blue River and Indian Creek watersheds. This includes one site-specific MS4 permit for the city of Kansas City, Mo., as well as three general stormwater MS4 permits in Missouri and seven stormwater MS4 permits in Kansas covering the communities in the Kansas City metropolitan area. The communities with general stormwater permits on the Missouri side of the watershed include Grandview, Raytown and Belton. This type of permit addresses pollutant contributions from urban runoff. Urban runoff has been found to carry high levels of bacteria and can be expected to exceed water quality criteria for bacteria during and immediately after storm events in most streams throughout the country (EPA 1983). Common sources of *E. coli* contamination in urban stormwater have been documented as being from both wild and domestic animals (Burton and Pitt 2002). Bacterial inputs to streams from urban runoff can be caused by sanitary sewer overflows as discussed in Section 3.1.1, but also commonly results from residential and green space runoff carrying domestic and wild animal wastes. A USGS study examining the effects of wastewater and combined sewer overflows on water quality in the Blue River watershed concluded that contributions of *E. coli* bacteria were roughly equally divided between dog, geese, human, and unknown sources. Leaking sewer lines, discharges from wastewater treatment plants and combined sewer overflows are likely to be the dominant sources of human derived *E. coli* in Blue River (USGS 2010). However, as noted above, bacteria from other animal sources can enter streams as contaminated runoff from urban areas, either directly or through storm sewer discharge. Therefore, urban runoff is a significant potential contributor of bacteria to Blue River and Indian Creek.

In the case of Blue River and Indian Creek, MS4 permits regulate almost all urban stormwater discharges for the watershed area. Approximately 84 percent of the entire watershed, and 94 percent of the watershed in Missouri, falls under MS4 regulation. This includes nearly 100 percent of both the Indian Creek watershed in Missouri and the entire Indian Creek watershed under MS4 control. All designated municipal areas in Missouri, with the exception of 1.9 square miles constituting The Village of Loch Lloyd, are covered by MS4 permits, and a review of land cover and aerial imagery indicates that very little land area outside of the municipal boundaries can be characterized as urban. For this reason, urban stormwater runoff is considered an MS4-regulated point source for this TMDL.

Although stormwater discharges are untreated, MS4 permit holders must develop, implement, and enforce stormwater management plans to prevent the input of harmful pollutants. These plans must include measurable goals, must be reported on annually, and must meet six minimum control measures. These six minimum control measures are public education and outreach,

public participation and involvement, illicit discharge detection and elimination, construction site runoff control, post-construction runoff control, and pollution prevention.

### 3.1.4 Other General and Stormwater Permits

In addition to site-specific permits and stormwater MS4 permits, there are a number of other facilities with general and stormwater permits within the Blue River and Indian Creek watersheds in Missouri, as outlined in Table 10 and Appendix B. General permits are issued to activities that are similar enough to be covered by a single set of requirements. Stormwater permits are issued to activities (e.g., land disturbance) that are similar enough to be covered by a single set of requirements and are expected to discharge in response to storm events. Both general and stormwater permits are meant to be flexible enough to allow for ease and speed of issuance while providing the required protection of water quality.

As noted previously, there are no permitted CAFOs within the Missouri side of the Blue River watershed. However, animal feeding operations where animals are maintained or fed under confined conditions but which maintain fewer than 300 animal units are not legally defined as CAFOs under Missouri state regulations. Additionally, facilities that are defined as CAFOs but which maintain fewer than 1,000 animal units are not required to obtain a Missouri State Operating Permit. Since these operations are not regulated by the Department there is no data available on their numbers or locations, but given that the Missouri portion of this watershed is almost entirely urban, it is unlikely that discharges from such facilities are a source of bacteria in either Blue River or Indian Creek.

The Department assumes that activities associated with general and stormwater permits in the watershed will be conducted in compliance with all permit conditions, including monitoring and discharge limitations. It is expected that compliance with these permits will result in bacterial loadings at or below applicable targets. For these reasons, these facilities are not expected to cause or contribute to the bacterial impairment of Blue River and Indian Creek.

### 3.1.5 Illicit Straight Pipe Discharges

Illicit straight pipe discharges of household waste are also potential point sources of bacteria. These sources are illegal and unpermitted discharges straight into streams or land areas and are different from illicitly connected sewers. However, there are no specific data on the number or presence of illicit straight pipe discharges of household waste in the Blue River and Indian Creek watersheds. Due to the presence of a sewerage system throughout the majority of the watershed, illicit straight pipe discharges are not expected to be significant contributors of *E. coli* to Blue River and Indian Creek. Illicit discharge detection and elimination is one of the six minimum control measures required by an MS4 permit, and any straight pipe discharges should be addressed under local codes and ordinances, and by the stormwater management plan, as applicable.

## 3.2 Nonpoint Sources

Nonpoint source pollution refers to pollution coming from diffuse, non-permitted sources that typically cannot be identified as entering a water body at a single location. They include all other categories of pollution not classified as being from a point source, and are exempt from Department permit regulations as per state rules at 10 CSR 20-6.010(1)(B)1. These sources involve stormwater runoff from non-regulated areas and are minor or negligible under low-flow conditions. Typical nonpoint sources of pollution that have the potential to influence water quality include onsite wastewater treatment systems, various sources associated with runoff from agricultural and non-MS4 permitted urban areas, and riparian corridor conditions.

### 3.2.1 Agricultural Runoff

Stormwater runoff from lands used for agricultural purposes is often a source of bacterial loading to water bodies. Activities associated with agricultural land uses that may contribute bacteria to a water body include manure fertilization of croplands or pastures, and livestock grazing. However, as noted in Section 2.5, row crop agriculture accounts for only 5.3 percent of the land use within the Missouri portion of the Blue River watershed, and 5.6 percent of the land use in the Blue River watershed as a whole. Similarly, land use classified as grassland, which may be used for livestock grazing, accounts for 11 percent of the watershed area in Missouri, and 17 percent of the entire watershed. This land use is concentrated primarily in the very southern edge of the watershed, in the headwaters and tributaries far from the main stem of Blue River (see Figure 4). In addition, a review of recent aerial imagery from the watershed has indicated that, consistent with the predominantly urban nature of the watershed, some of the areas classified as agricultural land are actually parks, cemeteries, athletic fields, or disturbed open spaces. So while agricultural runoff may potentially be a source of bacteria to Blue River, it is expected to be a minor source, given the relative insignificance of agricultural land use within the watershed and the potential for bacterial die-off before such runoff actually reaches Blue River. Having said that, open green spaces within urban watersheds may still contribute bacteria via stormwater runoff contaminated by wildlife and domestic pet waste, as noted in Section 3.1.3.

While the Blue River watershed is predominantly urban, the Indian Creek watershed may effectively be characterized as entirely urban. Row crop agriculture accounts for only 0.6 percent of the land use within the Missouri portion of the Indian Creek watershed, and 0.3 percent of the land use in the Indian Creek watershed as a whole. Similarly, land use classified as grassland accounts for 2.6 percent of the watershed area in Missouri, and only 0.8 percent of the entire watershed. As in the Blue River watershed, recent aerial imagery indicates that these areas are also actually parks, cemeteries, athletic fields, and other features of an urban landscape, a finding corroborated by the fact that these areas are surrounded by land use classified as urban.

### 3.2.2 Urban Runoff (non-MS4 areas)

Stormwater runoff from urban areas not having MS4 permits is considered a nonpoint source. Although previous Missouri 303(d) Lists cite urban nonpoint sources as the cause of the bacteria

impairments in Blue River and Indian Creek, almost the entire urban area within these watersheds falls within the jurisdiction of a number of MS4 permits in both Missouri and Kansas. Therefore, for the purposes of this TMDL, urban runoff within the Blue River and Indian Creek watersheds is considered a potential point source contributor of *E. coli*, rather than a nonpoint source. For this reason, there are essentially no nonpoint urban runoff sources likely to be contributing to the bacteria impairments of Blue River and Indian Creek. See Section 3.1.3 for discussion pertaining to the MS4 permits.

### 3.2.3 Onsite Wastewater Treatment Systems

When properly designed and maintained, onsite wastewater treatment systems (e.g., home septic systems) should not serve as a source of contamination to surface waters; however, onsite wastewater treatment systems do fail for a variety of reasons. When these systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration), there can be adverse effects to surface water quality (Horsley and Witten 1996). Failing onsite wastewater treatment systems are known to be sources of bacteria, which can reach nearby streams through both surface runoff and groundwater flows, thereby contributing bacteria loads under either wet or dry weather conditions.

Onsite wastewater treatment systems in Jackson County, Mo. have been permitted by the county Public Works Department since 1985. This includes systems that have been installed, repaired or replaced since that time, but does not include systems that were installed or last modified before then. This also does not include systems within the Kansas City corporate limits, where the county Public Works Department has no jurisdiction (Steve Schnell, Jackson County Public Works, personal communication, Nov. 2, 2011). While data is not available at this time to estimate the number of existing systems in Jackson County outside of the Kansas City limits, the proportion of unincorporated area within the Blue River watershed is relatively small. However, the Kansas City Water Services Department does maintain a geospatial database identifying the locations of known and suspected onsite systems within the city limits. From this database, the number of onsite wastewater treatment systems on the Missouri side of the Blue River watershed (excluding Indian Creek) is estimated at 2,851, and the number of such onsite systems on the Missouri side of the Indian Creek watershed is 108 (Kansas City 2011).

Onsite wastewater treatment systems in Johnson County, Kan. have been regulated and permitted by the Johnson County Environmental Department since the 1960's, and the county maintains a record of all systems that have been installed, inspected or repaired since that time (Charlene Weiss, Johnson County Environmental Department, personal communication, Nov. 1, 2011). The locations of these onsite systems is maintained in a geospatial database by the Johnson County Automated Information Mapping System. From this database, the number of known, permitted onsite wastewater treatment systems on the Kansas side of the Blue River watershed (excluding Indian Creek) is estimated at 2,590, and the number of such onsite systems on the Kansas side of the Indian Creek watershed is 246 (Johnson County Environmental Department 2011a and Travis Wagner, Johnson County Automated Information Mapping System, email communication, Nov. 1, 2011). The actual number of systems may be as much as 18 percent greater in the Blue River watershed and 74 percent greater in the Indian Creek watershed, when

taking in consideration the number of non-permitted onsite systems estimated to be in these watersheds (Johnson County Environmental Department 2011b).

A study conducted by the Electric Power Research Institute suggests that 30 to 50 percent of onsite wastewater treatment systems in Missouri may be failing, and that in Kansas the failure rate may be 10 to 75 percent, depending upon the age of the system (EPRI 2000). These failure rates, combined with estimates of existing onsite systems, suggest that failing systems may potentially be a significant source of bacteria to Blue River and Indian Creek. It should be emphasized, however, that these suspected failure rates are sometimes based on unconfirmed estimates and other general information, and are not specific to this watershed. Therefore, it is not possible to accurately assess the degree to which these systems are truly contributing to the bacteria impairment of Blue River and Indian Creek.

### 3.2.4 Riparian Corridor Conditions

Riparian (streamside) corridor conditions can have a strong influence on instream water quality. Wooded riparian buffers are a vital functional component of stream ecosystems and are instrumental in the detention, removal and assimilation of pollutants from runoff. Therefore, a stream with good riparian cover is better able to moderate the impacts of high pollutant loads than a stream with poor, or no, riparian cover. However, with respect to bacteria, vegetated areas may be considered a source due to inputs from pets and wildlife and may, in fact, contribute to the impairment in Blue River and Indian Creek.

Table 13 presents land use data for the riparian corridor within the Blue River watershed. This analysis used the land use data calculated in Section 2.5 and defined the riparian corridor as a 30-meter area on each side of all streams within the watershed included in the National Hydrography Dataset 1: 24,000 scale flowline.[13] As can be seen in Table 13, the riparian corridor of Blue River can be characterized as predominantly urban, with forest and grassland comprising the majority of other land uses. As noted previously, it is likely that many of the areas classified as forest and grassland are actually features of a more urban landscape such as parks, cemeteries, athletic fields. Runoff from these areas, like runoff from impervious and residential areas, is likely to be a source of bacteria from pet waste and from wildlife that tend to concentrate in urban areas, such as geese. Having said that, it should be noted that approximately 78 percent of the riparian buffer within the Blue River watershed, whether classified as urban, forest or grassland, is regulated under MS4 permits, therefore making stormwater runoff from these areas a regulated point source (see Section 3.1.3). While rural, agricultural areas potentially contributing bacteria from wildlife and livestock activities do exist, these are not a significant part of the watershed and are not considered to be a significant source of bacteria.

[13] The National Hydrography Dataset is digital surface water data for geographic information systems (GIS) for use in general mapping and in the analysis of surface-water systems. Available URL: http://nhd.usgs.gov

**Table 13. Land use/land cover for the Blue River riparian buffer, 30-meter (MoRAP 2005 and KARS 2008).**

| Land Use/ Land Cover | Missouri Watershed Area | | | Kansas Watershed Area | | | Entire Watershed Watershed Area | | |
|---|---|---|---|---|---|---|---|---|---|
| | Acres | Square Miles | Percent | Acres | Square Miles | Percent | Acres | Square Miles | Percent |
| Urban | 1666 | 2.6 | 38.8 | 4674 | 7.3 | 54.9 | 6339 | 9.9 | 49.5 |
| Cropland | 175 | 0.3 | 4.1 | 221 | 0.3 | 2.6 | 396 | 0.6 | 3.1 |
| Grassland | 459 | 0.7 | 10.7 | 1823 | 2.8 | 21.4 | 2281 | 3.6 | 17.8 |
| Forest/Woodland | 1444 | 2.3 | 33.6 | 1591 | 2.5 | 18.7 | 3035 | 4.7 | 23.7 |
| Open Water | 180 | 0.3 | 4.2 | 199 | 0.3 | 2.3 | 380 | 0.6 | 3.0 |
| Barren | 0 | 0.0 | 0.0 | 5 | 0.0 | 0.1 | 5 | 0.0 | 0.0 |
| Herbaceous | 45 | 0.1 | 1.0 | ND | ND | ND | 45 | 0.1 | 0.4 |
| Wetland | 326 | 0.5 | 7.6 | ND | ND | ND | 326 | 0.5 | 2.5 |
| **Total** | 4295 | 6.8 | 100 | 8513 | 13.2 | 100 | 12807 | 20.0 | 100 |

Note: MoRAP = Missouri Resource Assessment Partnership
KARS = Kansas Applied Remote Sensing Program
ND = No Data. At the time of this TMDL, data were not available to estimate area of herbaceous and wetland land cover in Kansas.

# 4 Applicable Water Quality Standards and Numeric Water Quality Targets

The purpose of developing a TMDL is to identify the pollutant loading that a water body can receive and still achieve water quality standards. Water quality standards are therefore central to the TMDL development process. Under the federal Clean Water Act, every state must adopt water quality standards to protect, maintain, and improve the quality of the nation's surface waters (U.S Code Title 33, Chapter 26, Subchapter III (U.S. Code 2009)). Water quality standards consist of three components: designated beneficial uses, water quality criteria to protect those uses, and an antidegradation policy.

## 4.1 Designated Beneficial Uses

Designated beneficial uses are the uses for a water body identified in the state water quality standards that must be maintained in accordance with the federal Clean Water Act. The following designated beneficial uses have been assigned to Blue River and Indian Creek:

- Livestock and Wildlife Watering
- Protection of Warm Water Aquatic Life
- Protection of Human Health (Fish Consumption)
- Whole Body Contact Recreation – Category A (0419 and 0420)
- Whole Body Contact Recreation – Category B (0417, 0418 and 0421)
- Secondary Contact Recreation (0418, 0419 and 0421)
- Industrial (0417, 0418 and 0420)

The use impaired by bacteria in this stream is the protection of whole body contact recreation, categories A and B, and secondary contact recreation. Whole body contact recreation includes activities in which there is direct human contact with surface water that results in complete body submergence, thereby allowing accidental ingestion of the water as well as direct contact to sensitive body organs, such as the eyes, ears and nose. Category A waters include water bodies that have been designated as public swimming areas and waters with existing whole body contact recreational uses. Category B applies to waters designated for whole body contact recreation, but are not contained within category A. Secondary contact recreation includes activities where contact with the water is either accidental or incidental and the likelihood of ingesting large quantities of water is minimal. The designated uses and stream classifications for Missouri may be found in the Water Quality Standards at 10 CSR 20-7.031(1)(C),-(1)(F) and Table H (Missouri Secretary of State 2010).

## 4.2 Water Quality Criteria

Water quality criteria are limits on particular chemicals or conditions in a water body to protect particular designated beneficial uses. Water quality criteria can be expressed as specific numeric criteria or as general narrative statements.

Specific numeric criteria established for the protection of whole body and secondary contact recreation can be found in Missouri's Water Quality Standards at 10 CSR 20-7.031(4)(C). For whole body contact category A waters, *E. coli* counts, measured as a geometric mean during the recreational season (April 1 – October 31), shall not exceed 126 counts/100 mL of water. For category B waters, the geometric mean during the recreational season shall not exceed 206 counts/100 mL of water. For waters designated for secondary contact recreation, the *E. coli* geometric mean during the recreational season shall not exceed 1,134 counts/100 mL of water.

## 4.3 Antidegradation Policy

Missouri's water quality standards include EPA's "three-tiered" approach to antidegradation, which may be found at 10 CSR 20-7.031(2) (Missouri Secretary of State 2010).

> Tier 1 – Protects existing uses and a level of water quality necessary to maintain and protect those uses. Tier 1 provides the absolute floor of water quality for all waters of the United States. Existing in-stream water uses are those uses that were attained on or after November 28, 1975, the date of EPA's first Water Quality Standards Regulation.
>
> Tier 2 – Protects and maintains the existing level of water quality where it is better than applicable water quality criteria. Before water quality in Tier 2 waters can be lowered, there must be an antidegradation review consisting of: (1) a finding that it is necessary to accommodate important economic and social development in the area where the waters are located; (2) full satisfaction of all intergovernmental coordination and public participation provisions; and (3) assurance that the highest statutory and regulatory

requirements for point sources and best management practices for nonpoint sources are achieved. Furthermore, water quality may not be lowered to less than the level necessary to fully protect the "fishable/swimmable" uses and other existing uses.

Tier 3 – Protects the quality of outstanding national and state resource waters, such as waters of national and state parks, wildlife refuges, and exceptional recreational or ecological significance. There may be no new or increased discharges to these waters and no new or increased discharges to tributaries of these waters that would result in lower water quality.

Waters in which a pollutant is at, near or exceeds the water quality criteria are considered in Tier 1 status for that pollutant. Therefore, the antidegradation goals for Blue River and Indian Creek are to restore the streams' water quality to levels that meet water quality standards.

## 4.4 Numeric Targets

Since Missouri's Water Quality Standards include specific numeric *E. coli* water quality criteria for whole body contact recreation categories A and B designated uses, these values will serve as the numeric targets for TMDL development. Because these criteria are more restrictive than the criterion for secondary contact recreation, these targets will also be protective of the secondary contact recreation use. As noted in Section 4.1, the whole body contact recreation category A designated use is assigned to Indian Creek and Blue River segment 0419, and the whole body contact recreation category B designated use is assigned to Blue River segments 0417, 0418 and 0421. And as noted in Section 4.2, the specific numeric criterion for whole body contact recreation category A is a concentration of 126 *E. coli* counts per 100 mL of water measured as a geometric mean during the recreational season, and the criterion for category B waters is a concentration of 206 *E. coli* counts per 100 mL of water measured as a geometric mean during the recreational season. These targeted concentrations will be expressed as daily loads using a load duration curve approach. Achieving these targeted loads will also result in achieving the state's whole body contact water quality criteria.

Given the number of impaired water body segments in the Blue River watershed, a discussion of water quality criteria in the TMDL development process should take into consideration the issue of downstream designated uses. Federal water quality standards regulation 40 CFR § 131.10(b) establishes that each state "shall ensure that its water quality standards provide for the attainment and maintenance of the water quality standards of downstream waters." With one exception, the impaired water body segments in the Blue River watershed are assigned uses and criteria that are as protective, or more protective, as the criteria and uses assigned to downstream segments. The exception is water body segment 0419, with a more stringent whole body contact recreation category A criterion, downstream of water body segment 0421, assigned a category B criterion. Even so, there is no evidence to date to demonstrate that the criterion for segment 0421 is not protective of downstream uses. Rather, the impairment in segment 0419 is linked to the *exceedances* of established water quality criteria that occur in segment 0421 and throughout the river, which this TMDL is intended to address. Since the criterion for water body segment 0421 is currently established in Missouri's water quality standards rules, this is the criterion that must

be used to establish TMDL allocations for this segment at this time. It is not the purview of this TMDL to revise existing water quality standards. In the event that future water quality monitoring in Blue River does demonstrate that water quality standards for water body segment 0421 are not protective of downstream standards, the Clean Water Act provides means to address this situation. EPA guidance established in its Water Quality Standards Handbook notes that the Act provides a mechanism for establishing new or revised water quality standards where needed. The Handbook also points out that Sections 401 and 402 of the Act establish that the National Pollutant Discharge Elimination System (NPDES) program set permit limits that are required to comply with applicable water quality standards, including those downstream (EPA 1994).

# 5 TMDL Development

## 5.1 Water Quality and Stream Flow Data

As noted in Section 2.6 of this document, bacterial water quality data for each of the five impaired segments were collected and analyzed by the USGS, EPA Region 7, and the Kansas Department of Health and Environment between 1998 and 2010. In addition to being used to assess impairments, this observed data is plotted with stream flow to compare against water quality targets throughout the range of flows. See Table 8 in Section 2.6 for a list of recreation season *E. coli* geometric means for each impaired segment, and see Appendix A for a list of all *E. coli* sample data.

Stream flow data for Blue River and Indian Creek were available from six USGS gaging stations, four on Blue River and two on Indian Creek, for the period of Jan. 1, 1990 through Oct. 7, 2010 (Appendix D, Table D.1).

## 5.2 Modeling Approach

For Blue River and Indian Creek, the load duration curve approach was used. When stream flow gage information is available, a load duration curve is useful in identifying and differentiating between storm-driven and steady-input sources. A load duration curve also identifies the maximum allowable daily pollutant load for any given day as a function of the flow occurring that day. The load duration approach may be used to assess critical conditions, to provide a visual representation of stream flow conditions under which bacteria criteria exceedances have occurred, and to quantify the level of reduction necessary to meet the surface water quality targets for bacteria in the stream (Cleland 2002; Cleland 2003).

The first step in developing a load duration curve is establishing a record of flow to be used, and developing a flow duration curve based on this record. A flow duration curve and a synthetic flow record of daily flow per square mile for Blue River and Indian Creek were developed using data from the six gaging stations within the Blue River watershed. Average daily flow per square mile from all of the stations was calculated for each day of record and multiplied by the area of each watershed for which load duration curves were to be developed. These include the entire Blue River watershed, the Indian Creek watershed, and the immediate subwatersheds

draining to each of the four individual Blue River water body segments. This results in an estimation of flow for each of the larger watersheds, as well as an estimation of flow that is contributed only by the drainage area adjacent to each individual segment. The flow estimated for each segment does not take into consideration flow contributed by upstream water body segments (and their watersheds), and eliminates the possibility of the same contributing flow being counted more than once for different water body segments. This approach was used to estimate average daily flow for each day during the period from Jan. 1, 1990 through Oct. 7, 2010,. Additional discussion of the methods used to develop the bacteria load duration curve is presented in Appendix D.

The load duration curve approach used in this TMDL to express geometric mean bacteria concentrations as daily loads is consistent with the Anacostia Ruling (*Friends of the Earth, Inc., et al v. EPA*, No 05-5010, April 25, 2006) and EPA guidance in response to this ruling. The November 15, 2006 EPA "daily loads" memo recommends that all TMDLs and associated pollutant allocations be expressed in terms of daily time increments, and suggests that there is flexibility in how these daily increments may be expressed. In particular, the memo indicates that where pollutant loads or water body flows are highly dynamic, it may be appropriate to use a load duration curve approach, provided that such an approach "identifies the allowable daily pollutant load for any given day as a function of the flow occurring on that day". In addition, for targets that are expressed as a concentration of a pollutant, it may be appropriate to use a table or graph to express individual daily loads over a range of flows as a product of a water quality criterion multiplied by stream flow and a conversion factor (EPA 2006). The load duration curve approach satisfied both of these conditions. Subsequent EPA guidance detailing options for expressing daily loads in TMDLs confirms and elaborates upon the appropriateness of using the load duration curve approach for translating water quality criteria expressed as concentrations into daily loads (EPA 2007a).

# 6 Calculation of Loading Capacity

The loading capacity, or TMDL, is the maximum pollutant load that a water body can assimilate and still maintain water quality standards. It is equal to the sum of the wasteload allocation, attributable to point sources of pollutants, the load allocation, attributable to nonpoint sources of pollutants, and the margin of safety. Loading capacity can be expressed as the equation

$$LC = \sum WLA + \sum LA + MOS$$

where LC is the loading capacity, $\sum$WLA is the sum of all wasteload allocations, $\sum$LA is the sum of all load allocations, and MOS is the margin of safety.

The loading capacity is calculated by multiplying stream flow in cubic feet per second, or cfs, by the maximum allowable bacteria concentration (the water quality criterion) in counts per 100 mL of water. A conversion factor is used to convert the units (cfs and counts per 100 mL) to counts per day.

*(streamflow, cfs)(maximum allowable pollutant concentration, counts/100mL)(conversion) = counts/day*

According to 40 CFR § 130.2(i), TMDLs can be expressed in terms of mass per time, toxicity or other appropriate measures. For Blue River and Indian Creek, bacteria TMDLs (loads) are expressed as *E. coli* counts per day using a load duration curve. The load duration curves presented in Figures 12 through 17 represent the maximum daily loading capacity for Blue River at its outlet with the Missouri River, for Indian Creek at its outlet with Blue River, and for each individual Blue River water body segment. These were calculated using the geometric mean water quality criteria as a solid line over the range of flows associated with each watershed or subwatershed (see Figure 1 for impaired segments and their subwatershed boundaries). Bacteria measurements from Blue River and Indian Creek observed during the recreational season (Apr. – Oct.) are plotted as blue points for comparison with this TMDL curve. Geometric means of observed data within a specific flow category (i.e., high flows, moist conditions, etc.) are plotted as yellow triangles for comparison with the curve. Flow conditions presented in the following figures illustrate general base-flow and surface-runoff conditions consistent with EPA guidance on using load duration curves for TMDL development (EPA 2007b). These figures also illustrate that higher *E. coli* counts per day and exceedances of water quality criteria generally appear to be more common at higher flows, indicating that high flows may represent critical conditions for bacteria impairments in Blue River and Indian Creek. Individual bacteria measurements can be found in Appendix A and geometric means for all water bodies are summarized in Table 8 of Section 2.6. Tables presenting the TMDL loading capacities and TMDL allocations over a range of flows can be found in Section 7, below.

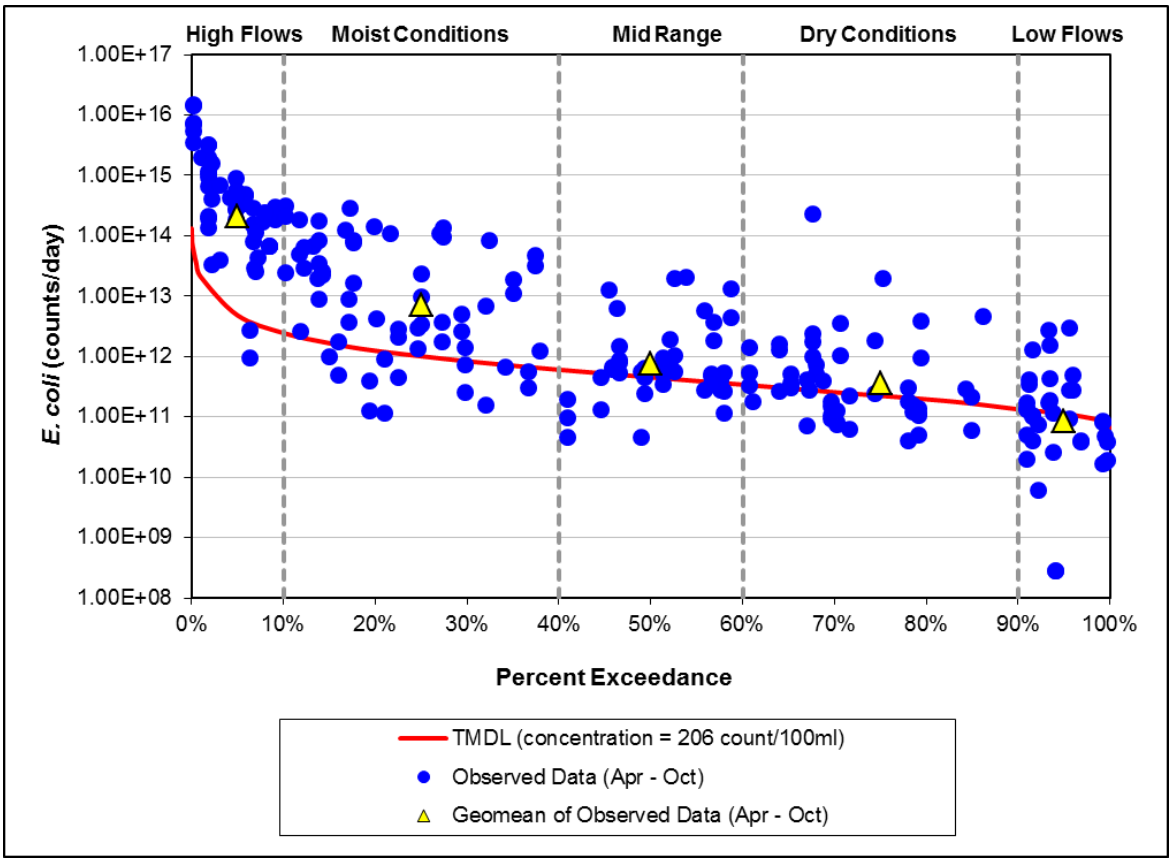


**Figure 12. Blue River load duration curve (all segments in watershed)**

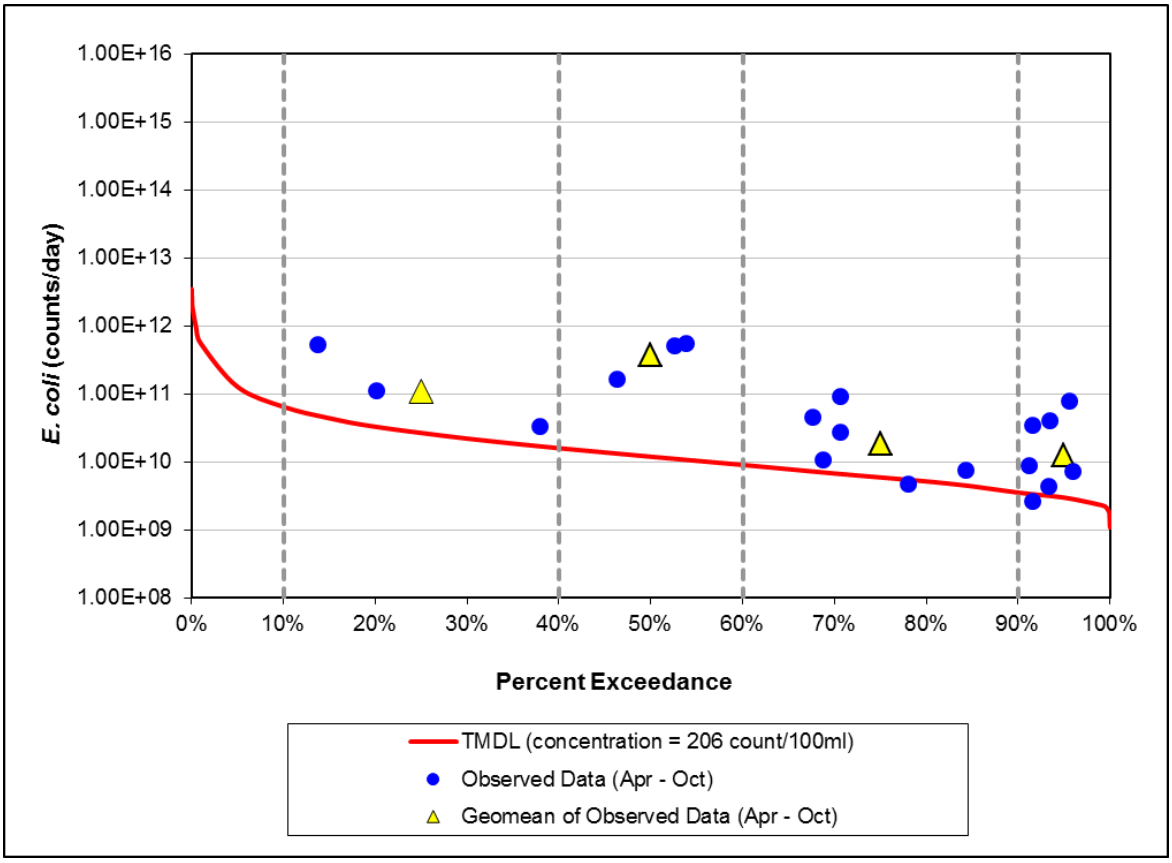


**Figure 13. Blue River (segment WBID 0417) load duration curve**

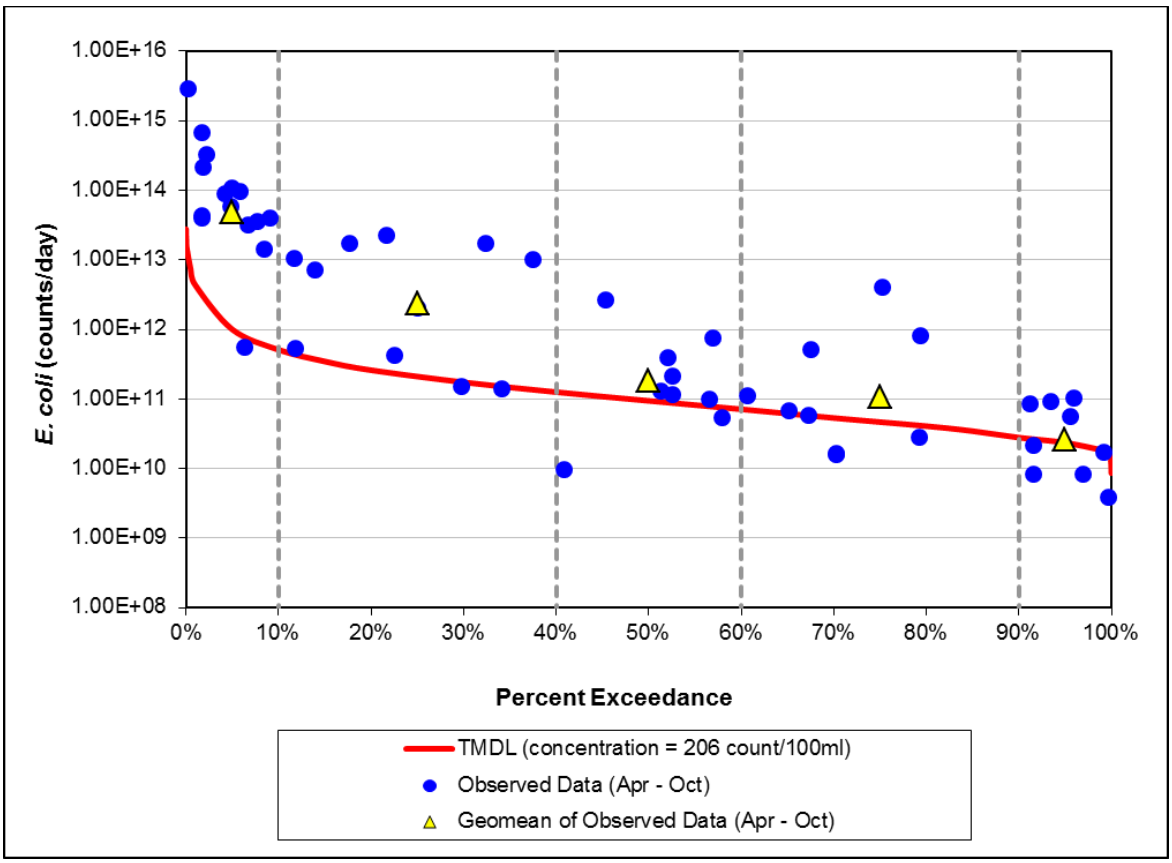


**Figure 14. Blue River (segment WBID 0418) load duration curve**

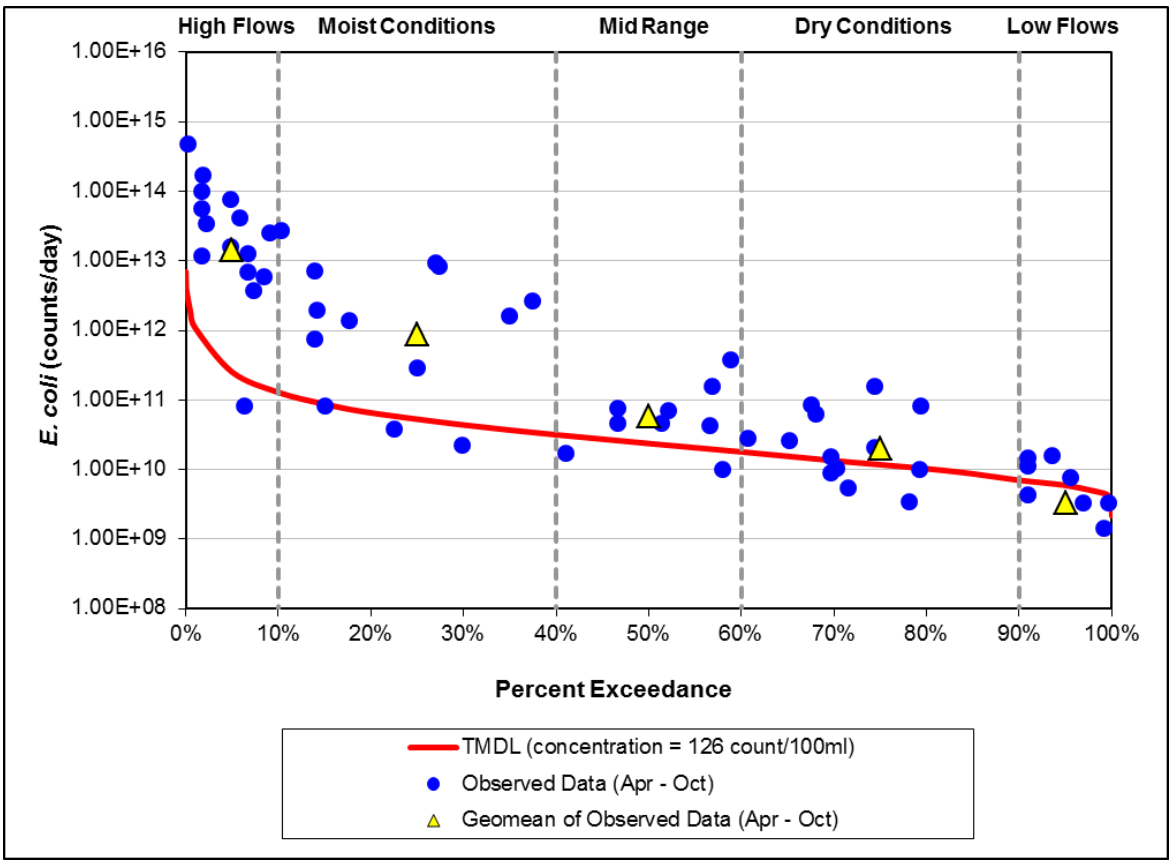


**Figure 15. Blue River (segment WBID 0419) load duration curve**

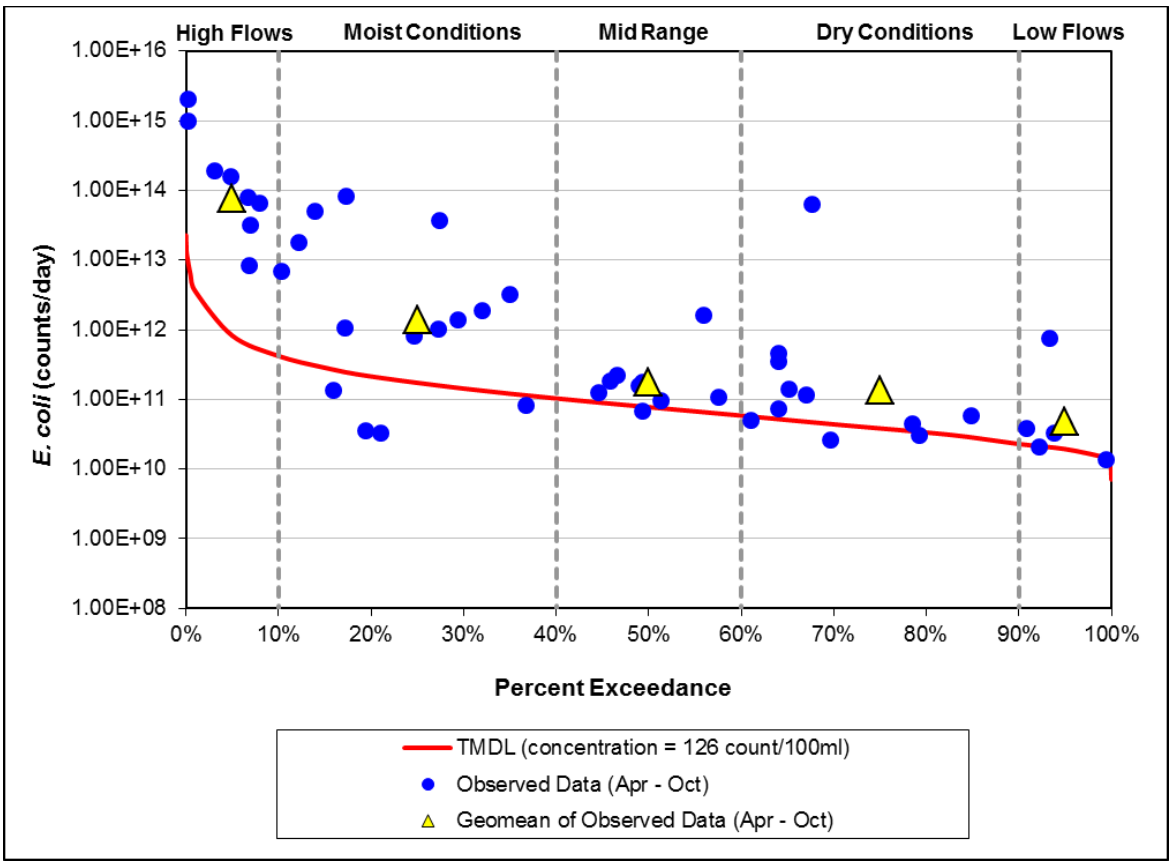


**Figure 16. Indian Creek (WBID 0420) load duration curve**

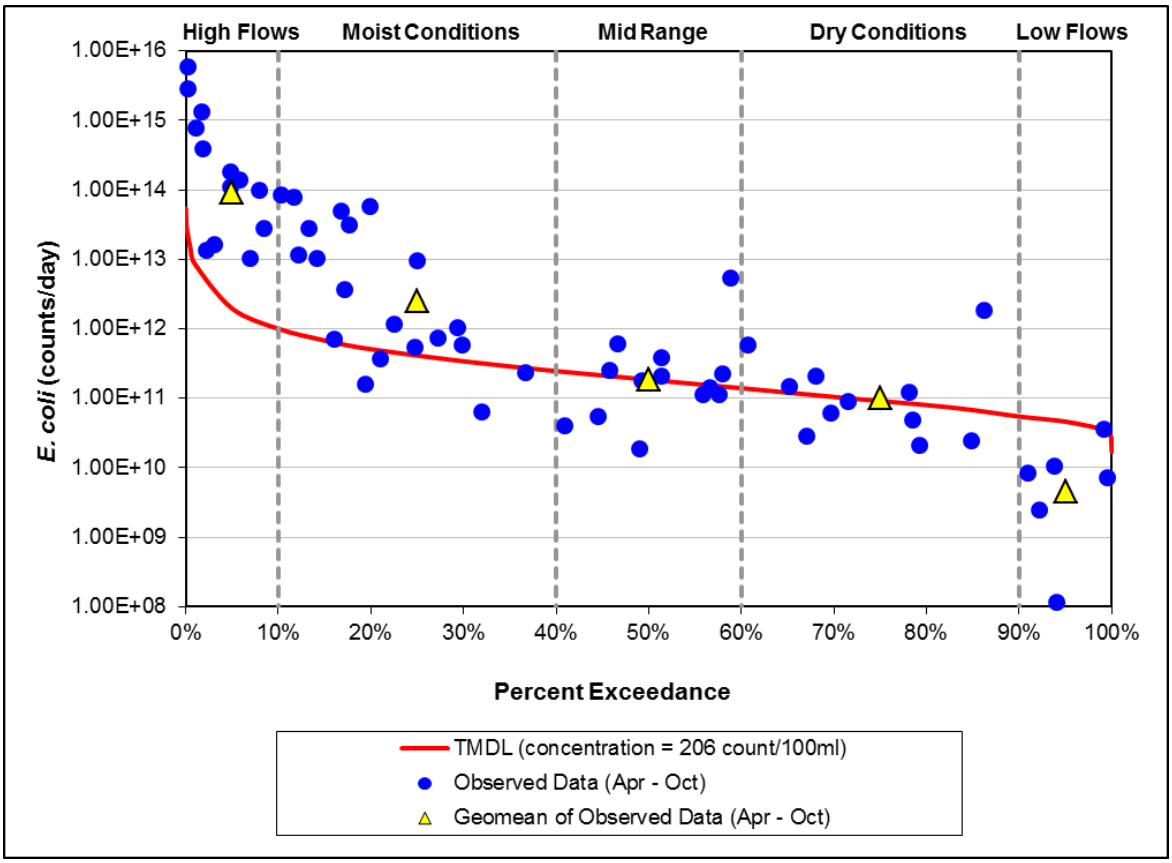


**Figure 17. Blue River (segment WBID 0421) load duration curve**

# 7 Wasteload Allocation (Point Source Load)

The wasteload allocation is the allowable amount of the pollutant that can be allocated to existing or future point sources. Typically, point sources are permitted with limits for a given pollutant that are the most stringent of either technology-based effluent limits or water quality-based effluent limits. Technology-based effluent limits are based upon the expected capability of a treatment method to reduce the pollutant to a certain concentration. Water quality-based effluent limits represent the most stringent concentration of a pollutant that a receiving stream can assimilate without violating applicable water quality criteria at a specific location. Tables 14 through 29 present the TMDL loading capacity and TMDL allocations over a range of flows for Blue River and Indian Creek at their outlets, as well as for each individual impaired segment of Blue River. These include tables that present the combined sewer overflow and MS4 wasteload allocation portion of each TMDL and, where applicable, include separate tables that present loading capacities and allocations for only the Missouri portion of each watershed. In addition to presenting pollutant allocations for the entire Blue River and Indian Creek watersheds, allocations are presented for the subwatersheds draining directly to each impaired segment (Figure 1). Allocations are calculated in this way to eliminate overlapping watersheds that have differing whole body contact recreation criteria , and that would otherwise result in assigning

multiple and conflicting MS4 wasteload allocations to each permitted municipal entity. It should be noted that because of the differing whole body contact recreation criteria among segments, the sum of the loading capacities and allocations for each segment at each flow are not equal to the loading capacities and allocations for the entire Blue River watershed at the corresponding flows.

Any TMDL allocations attributable to Kansas are presented for informational purposes only. In order to meet TMDL targets in Missouri, it must be assumed that point source contributions from the Kansas portion of the watershed do not cause or contribute to the impairments and that Missouri's water quality standards are met at the state line. This assumption is consistent with the federal water quality standards regulation, discussed in Section 4.4, that establish that a state's water quality standards must provide for the attainment and maintenance of water quality standards of downstream waters [40 CFR § 131.10(b)].

As noted in Sections 3.1.1 and 3.1.3, there are several site-specific permitted point sources in the Missouri portion of the Blue River watershed that have the potential to contribute to *E. coli* loading. Two of these, the Missouri Department of Conservation Discovery Center (impaired segment 0418) and Sneads Bar-B-Q (impaired segment 0421), have such low design flows that any bacteria contributions are expected to be insignificant. For this reason individual wasteload allocations have not been established for these facilities. Although the Kansas City Blue River Wastewater Treatment Facility discharges outside of the watershed, a sewerage system associated with this facility is present in the watershed. This system includes both sanitary sewers and combined sewers. Discharges from sanitary sewers are unpermitted and are not authorized by the federal Clean Water Act and, although sanitary sewer overflows do occur, there are no constructed sanitary sewer outfalls in the Blue River watershed. For these reasons, sanitary sewer overflows are not given a wasteload allocation in this TMDL. The elimination of sanitary sewer overflows to the greatest extent possible is essential for improving water quality in the Blue River watershed.

Unlike sanitary sewers, discharges from combined sewers are not specifically unauthorized by the Clean Water Act. However, EPA's 1994 Combined Sewer Overflow Control Policy establishes an approach for controlling discharges from combined sewer systems through the National Pollutant Discharge Elimination System in order to achieve compliance with water quality standards and to protect designated uses (Fed. Reg. 1994). Because of this, combined sewer overflows associated with the Kansas City Blue River Wastewater Treatment Facility are given wasteload allocations in this TMDL which were developed using numeric targets for projected end-of-plan overflow volumes established in Kansas City's Overflow Control Plan[14]. (See Appendix C for a list of known combined sewer outfalls in the Blue River watershed.) Pollutant allocations were calculated using the method outlined in Section 6, with flow defined by the projected overflow volumes established in the Plan according to Missouri's effluent regulations at 10 CSR 20-7.015. These regulations state that the permitting and control of combined sewer overflows shall conform to EPA's Combined Sewer Overflow Control Policy, which, by extension, includes the Overflow Control Plan. In this way, pollutant allocations assigned to combined sewer overflows in this TMDL document will be tied directly to projected end-of-plan overflow volumes and will not be more restrictive than what is already established

[14] Section 12.6, Tables 12-4, 12-5, 12-7, 12-10 and 12-13 (Kansas City 2009).

by the Overflow Control Plan. As noted previously, there are no combined sewer outfalls in the Indian Creek watershed, nor in the watershed of impaired Blue River segment WBID 0421.

Urban stormwater runoff from MS4 permitted entities is another likely significant contributor of point source bacteria loading to Blue River and Indian Creek. The Missouri side of the Blue River watershed contains portions of four permitted MS4 areas: Kansas City, with a site-specific permit, and Grandview, Raytown and Belton, with general stormwater permits. The MS4 wasteload allocations for each entity within each impaired segment watershed are established based on the proportion of watershed covered by that entity's permit. Bacterial contributions from MS4-permitted entities are precipitation dependent and vary with flow. Therefore, the MS4 wasteload allocations increase at higher storm flows as available diffuse flow increases.

The wasteload allocations established in this TMDL do not preclude the establishment of future point sources of bacterial loading in the watershed. Any future point sources should be evaluated against the TMDL and the range of flows, which any additional bacterial loading will affect.

## 7.1 TMDL Allocations for Blue River - All Segments

**Table 14. *E. coli* TMDL for Blue River watershed over a range of flow conditions – Missouri and Kansas†**

| *Percentile Flow Exceedance* | *Flow (cfs)* | *Targets Based on Geometric Mean* | | | |
|---|---|---|---|---|---|
| | | *TMDL (counts/day)* | *Sum WLA (counts/day)* | *LA (counts/day)* | *MOS (counts/day)* |
| 95 | 22.5 | 1.13E+11 | 9.38E+10 | 8.09E+09 | 1.13E+10 |
| 90 | 26.6 | 1.34E+11 | 1.11E+11 | 9.57E+09 | 1.34E+10 |
| 70 | 50.8 | 2.56E+11 | 2.12E+11 | 1.83E+10 | 2.56E+10 |
| 50 | 89.8 | 4.52E+11 | 3.75E+11 | 3.23E+10 | 4.52E+10 |
| 30 | 165.7 | 8.35E+11 | 6.92E+11 | 5.97E+10 | 8.35E+10 |
| 10 | 486.6 | 2.45E+12 | 2.03E+12 | 1.75E+11 | 2.45E+11 |
| 5 | 955.7 | 4.82E+12 | 3.99E+12 | 3.44E+11 | 4.82E+11 |

† See Figure 12 load duration curve.

**Table 15. *E. coli* TMDL for Blue River watershed over a range of flow conditions – Missouri only**

| *Percentile Flow Exceedance* | *Flow (cfs)* | *Targets Based on Geometric Mean* | | | |
|---|---|---|---|---|---|
| | | *TMDL (counts/day)* | *Sum WLA (counts/day)* | *LA (counts/day)* | *MOS (counts/day)* |
| 95 | 9.3 | 4.87E+10 | 4.37E+10 | 2.71E+08 | 4.71E+09 |
| 90 | 11.0 | 5.79E+10 | 5.21E+10 | 3.20E+08 | 5.57E+09 |
| 70 | 21.1 | 1.12E+11 | 1.01E+11 | 6.13E+08 | 1.07E+10 |
| 50 | 37.3 | 1.97E+11 | 1.77E+11 | 1.08E+09 | 1.88E+10 |
| 30 | 68.9 | 3.62E+11 | 3.25E+11 | 2.00E+09 | 3.47E+10 |
| 10 | 202.4 | 1.05E+12 | 9.46E+11 | 5.87E+09 | 1.02E+11 |
| 5 | 397.5 | 2.06E+12 | 1.85E+12 | 1.15E+10 | 2.00E+11 |

**Table 16. *E. coli* WLA for Blue River watershed over a range of flow conditions – Wasteload allocations for Missouri designated MS4s and CSOs**

| *Percentile Flow Exceedance* | *Targets Based on Geometric Mean* | | | | |
|---|---|---|---|---|---|
| | *CSO (counts/day)* | *Kansas City MS4 (counts/day)* | *Grandview MS4* (counts/day)* | *Raytown MS4 (counts/day)* | *Belton MS4* (counts/day)* |
| 95 | 7.71E+08 | 3.96E+10 | 1.44E+09 | 1.01E+09 | 8.95E+08 |
| 90 | 1.54E+09 | 4.65E+10 | 1.69E+09 | 1.19E+09 | 1.05E+09 |
| 70 | 4.62E+09 | 8.84E+10 | 3.21E+09 | 2.26E+09 | 2.00E+09 |
| 50 | 7.71E+09 | 1.56E+11 | 5.68E+09 | 4.00E+09 | 3.53E+09 |
| 30 | 1.08E+10 | 2.90E+11 | 1.05E+10 | 7.42E+09 | 6.56E+09 |
| 10 | 1.39E+10 | 8.59E+11 | 3.13E+10 | 2.20E+10 | 1.94E+10 |
| 5 | 1.46E+10 | 1.69E+12 | 6.16E+10 | 4.33E+10 | 3.83E+10 |

## 7.2 TMDL Allocations for Blue River – WBID 0417

**Table 17. *E. coli* TMDL for WBID 0417 impaired segment watershed over a range of flow conditions – Missouri only†**

| *Percentile Flow Exceedance* | *Flow (cfs)* | *Targets Based on Geometric Mean* | | | |
|---|---|---|---|---|---|
| | | *TMDL (counts/day)* | *Sum WLA (counts/day)* | *LA (counts/day)* | *MOS (counts/day)* |
| 95 | 0.6 | 2.97E+09 | 2.66E+09 | 8.23E+06 | 2.97E+08 |
| 90 | 0.7 | 3.51E+09 | 3.15E+09 | 8.40E+06 | 3.51E+08 |
| 70 | 1.3 | 6.72E+09 | 6.04E+09 | 1.25E+07 | 6.72E+08 |
| 50 | 2.4 | 1.19E+10 | 1.07E+10 | 2.31E+07 | 1.19E+09 |
| 30 | 4.3 | 2.19E+10 | 1.97E+10 | 5.00E+07 | 2.19E+09 |
| 10 | 12.8 | 6.43E+10 | 5.77E+10 | 1.84E+08 | 6.43E+09 |
| 5 | 25.1 | 1.26E+11 | 1.13E+11 | 3.89E+08 | 1.26E+10 |

† See Figure 13 load duration curve.

**Table 18. *E. coli* WLA for WBID 0417 over a range of flow conditions – Wasteload allocations for Missouri designated MS4s and CSOs**

| *Percentile Flow Exceedance* | *Targets Based on Geometric Mean* | | | | |
|---|---|---|---|---|---|
| | *CSO (counts/day)* | *Kansas City MS4 (counts/day)* | *Grandview MS4* (counts/day)* | *Raytown MS4* (counts/day)* | *Belton MS4* (counts/day)* |
| 95 | 4.42E+08 | 2.22E+09 | 0 | 0 | 0 |
| 90 | 8.84E+08 | 2.27E+09 | 0 | 0 | 0 |
| 70 | 2.65E+09 | 3.38E+09 | 0 | 0 | 0 |
| 50 | 4.42E+09 | 6.24E+09 | 0 | 0 | 0 |
| 30 | 6.19E+09 | 1.35E+10 | 0 | 0 | 0 |
| 10 | 7.96E+09 | 4.98E+10 | 0 | 0 | 0 |
| 5 | 8.40E+09 | 1.05E+11 | 0 | 0 | 0 |

* MS4 entities not represented in the WBID 0417 impaired segment watershed.

## 7.3 TMDL Allocations for Blue River – WBID 0418

**Table 19. *E. coli* TMDL for WBID 0418 impaired segment watershed over a range of flow conditions – Missouri and Kansas†**

| *Percentile Flow Exceedance* | *Flow (cfs)* | *Targets Based on Geometric Mean* | | | |
|---|---|---|---|---|---|
| | | *TMDL (counts/day)* | *Sum WLA (counts/day)* | *LA (counts/day)* | *MOS (counts/day)* |
| 95 | 4.7 | 2.36E+10 | 2.07E+10 | 5.77E+08 | 2.36E+09 |
| 90 | 5.5 | 2.79E+10 | 2.44E+10 | 6.76E+08 | 2.79E+09 |
| 70 | 10.6 | 5.34E+10 | 4.68E+10 | 1.28E+09 | 5.34E+09 |
| 50 | 18.7 | 9.43E+10 | 8.26E+10 | 2.26E+09 | 9.43E+09 |
| 30 | 34.5 | 1.74E+11 | 1.52E+11 | 4.21E+09 | 1.74E+10 |
| 10 | 101.4 | 5.11E+11 | 4.48E+11 | 1.25E+10 | 5.11E+10 |
| 5 | 199.2 | 1.00E+12 | 8.79E+11 | 2.47E+10 | 1.00E+11 |

† See Figure 14 load duration curve.

**Table 20. *E. coli* TMDL for WBID 0418 impaired segment watershed over a range of flow conditions – Missouri only**

| *Percentile Flow Exceedance* | *Flow (cfs)* | *Targets Based on Geometric Mean* | | | |
|---|---|---|---|---|---|
| | | *TMDL (counts/day)* | *Sum WLA (counts/day)* | *LA (counts/day)* | *MOS (counts/day)* |
| 95 | 3.6 | 1.79E+10 | 1.60E+10 | 1.41E+07 | 1.83E+09 |
| 90 | 4.3 | 2.12E+10 | 1.90E+10 | 1.66E+07 | 2.16E+09 |
| 70 | 8.2 | 4.06E+10 | 3.65E+10 | 3.13E+07 | 4.14E+09 |
| 50 | 14.5 | 7.17E+10 | 6.43E+10 | 5.54E+07 | 7.31E+09 |
| 30 | 26.8 | 1.32E+11 | 1.18E+11 | 1.03E+08 | 1.35E+10 |
| 10 | 78.6 | 3.86E+11 | 3.46E+11 | 3.07E+08 | 3.96E+10 |
| 5 | 154.3 | 7.58E+11 | 6.79E+11 | 6.06E+08 | 7.78E+10 |

**Table 21. *E. coli* WLA for WBID 0418 over a range of flow conditions – Wasteload allocations for Missouri designated MS4s and CSOs**

| *Percentile Flow Exceedance* | *Targets Based on Geometric Mean* | | | | |
|---|---|---|---|---|---|
| | *CSO (counts/day)* | *Kansas City MS4 (counts/day)* | *Grandview MS4* (counts/day)* | *Raytown MS4 (counts/day)* | *Belton MS4* (counts/day)* |
| 95 | 2.67E+08 | 1.49E+10 | 0 | 8.41E+08 | 0 |
| 90 | 5.33E+08 | 1.74E+10 | 0 | 9.86E+08 | 0 |
| 70 | 1.60E+09 | 3.30E+10 | 0 | 1.86E+09 | 0 |
| 50 | 2.67E+09 | 5.84E+10 | 0 | 3.30E+09 | 0 |
| 30 | 3.73E+09 | 1.09E+11 | 0 | 6.13E+09 | 0 |
| 10 | 4.80E+09 | 3.23E+11 | 0 | 1.83E+10 | 0 |
| 5 | 5.07E+09 | 6.38E+11 | 0 | 3.60E+10 | 0 |

* MS4 entities not represented in the WBID 0418 impaired segment watershed.

## 7.4 TMDL Allocations for Blue River – WBID 0419

**Table 22. *E. coli* TMDL for WBID 0419 impaired segment watershed over a range of flow conditions – Missouri only†**

| *Percentile Flow Exceedance* | *Flow (cfs)* | *Targets Based on Geometric Mean* | | | |
|---|---|---|---|---|---|
| | | *TMDL (counts/day)* | *Sum WLA (counts/day)* | *LA (counts/day)* | *MOS (counts/day)* |
| 95 | 1.9 | 5.95E+09 | 5.35E+09 | 0 | 5.95E+08 |
| 90 | 2.3 | 7.03E+09 | 6.33E+09 | 0 | 7.03E+08 |
| 70 | 4.4 | 1.35E+10 | 1.21E+10 | 0 | 1.35E+09 |
| 50 | 7.7 | 2.38E+10 | 2.14E+10 | 0 | 2.38E+09 |
| 30 | 14.2 | 4.39E+10 | 3.95E+10 | 0 | 4.39E+09 |
| 10 | 41.8 | 1.29E+11 | 1.16E+11 | 0 | 1.29E+10 |
| 5 | 82.1 | 2.53E+11 | 2.28E+11 | 0 | 2.53E+10 |

† See Figure 15 load duration curve.

**Table 23. *E. coli* WLA for WBID 0419 over a range of flow conditions – Wasteload allocations for Missouri designated MS4s and CSOs**

| *Percentile Flow Exceedance* | *Targets Based on Geometric Mean* | | | | |
|---|---|---|---|---|---|
| | *CSO (counts/day)* | *Kansas City MS4 (counts/day)* | *Grandview MS4* (counts/day)* | *Raytown MS4 (counts/day)* | *Belton MS4* (counts/day)* |
| 95 | 3.83E+07 | 5.27E+09 | 0 | 4.09E+07 | 0 |
| 90 | 7.65E+07 | 6.20E+09 | 0 | 4.81E+07 | 0 |
| 70 | 2.30E+08 | 1.18E+10 | 0 | 9.14E+07 | 0 |
| 50 | 3.83E+08 | 2.08E+10 | 0 | 1.62E+08 | 0 |
| 30 | 5.36E+08 | 3.87E+10 | 0 | 3.00E+08 | 0 |
| 10 | 6.89E+08 | 1.14E+11 | 0 | 8.87E+08 | 0 |
| 5 | 7.27E+08 | 2.25E+11 | 0 | 1.75E+09 | 0 |

* MS4 entities not represented in the WBID 0419 impaired segment watershed.

## 7.5 TMDL Allocations for Indian Creek – WBID 0420

**Table 24. *E. coli* TMDL for WBID 0420 impaired segment watershed over a range of flow conditions – Missouri and Kansas†**

| *Percentile Flow Exceedance* | *Flow (cfs)* | *Targets Based on Geometric Mean* | | | |
|---|---|---|---|---|---|
| | | *TMDL (counts/day)* | *Sum WLA (counts/day)* | *LA (counts/day)* | *MOS (counts/day)* |
| 95 | 6.2 | 1.91E+10 | 1.72E+10 | 1.21E+07 | 1.91E+09 |
| 90 | 7.3 | 2.26E+10 | 2.04E+10 | 1.43E+07 | 2.26E+09 |
| 70 | 14.1 | 4.33E+10 | 3.90E+10 | 2.73E+07 | 4.33E+09 |
| 50 | 24.8 | 7.65E+10 | 6.88E+10 | 4.82E+07 | 7.65E+09 |
| 30 | 45.8 | 1.41E+11 | 1.27E+11 | 8.90E+07 | 1.41E+10 |
| 10 | 134.6 | 4.15E+11 | 3.73E+11 | 2.61E+08 | 4.15E+10 |
| 5 | 264.3 | 8.15E+11 | 7.33E+11 | 5.13E+08 | 8.15E+10 |

† See Figure 16 load duration curve.

**Table 25. *E. coli* TMDL for WBID 0420 impaired segment watershed over a range of flow conditions – Missouri only**

| *Percentile Flow Exceedance* | *Flow (cfs)* | *Targets Based on Geometric Mean* | | | |
|---|---|---|---|---|---|
| | | *TMDL (counts/day)* | *Sum WLA (counts/day)* | *LA (counts/day)* | *MOS (counts/day)* |
| 95 | 0.5 | 1.61E+09 | 1.45E+09 | 0 | 1.61E+08 |
| 90 | 0.6 | 1.90E+09 | 1.71E+09 | 0 | 1.91E+08 |
| 70 | 1.2 | 3.64E+09 | 3.28E+09 | 0 | 3.65E+08 |
| 50 | 2.1 | 6.44E+09 | 5.79E+09 | 0 | 6.44E+08 |
| 30 | 3.9 | 1.19E+10 | 1.07E+10 | 0 | 1.19E+09 |
| 10 | 11.3 | 3.49E+10 | 3.14E+10 | 0 | 3.49E+09 |
| 5 | 22.3 | 6.85E+10 | 6.17E+10 | 0 | 6.86E+09 |

**Table 26. *E. coli* WLA for WBID 0420 over a range of flow conditions – Wasteload allocations for Missouri designated MS4s and CSOs**

| *Percentile Flow Exceedance* | *Targets Based on Geometric Mean* | | | | |
|---|---|---|---|---|---|
| | *CSO** (counts/day)* | *Kansas City MS4 (counts/day)* | *Grandview MS4* (counts/day)* | *Raytown MS4* (counts/day)* | *Belton MS4* (counts/day)* |
| 95 | 0 | 1.45E+09 | 0 | 0 | 0 |
| 90 | 0 | 1.71E+09 | 0 | 0 | 0 |
| 70 | 0 | 3.28E+09 | 0 | 0 | 0 |
| 50 | 0 | 5.79E+09 | 0 | 0 | 0 |
| 30 | 0 | 1.07E+10 | 0 | 0 | 0 |
| 10 | 0 | 3.14E+10 | 0 | 0 | 0 |
| 5 | 0 | 6.17E+10 | 0 | 0 | 0 |

* MS4 entities not represented in the WBID 0420 impaired segment watershed.
** No CSOs in the WBID 0420 impaired segment watershed.

## 7.6 TMDL Allocations for Blue River – WBID 0421

**Table 27. *E. coli* TMDL for WBID 0421 impaired segment watershed over a range of flow conditions – Missouri and Kansas†**

| *Percentile Flow Exceedance* | *Flow (cfs)* | *Targets Based on Geometric Mean* | | | |
|---|---|---|---|---|---|
| | | *TMDL (counts/day)* | *Sum WLA (counts/day)* | *LA (counts/day)* | *MOS (counts/day)* |
| 95 | 9.0 | 4.56E+10 | 2.42E+10 | 1.68E+10 | 4.56E+09 |
| 90 | 10.7 | 5.39E+10 | 2.86E+10 | 1.99E+10 | 5.39E+09 |
| 70 | 20.5 | 1.03E+11 | 5.48E+10 | 3.81E+10 | 1.03E+10 |
| 50 | 36.2 | 1.82E+11 | 9.67E+10 | 6.73E+10 | 1.82E+10 |
| 30 | 66.8 | 3.37E+11 | 1.79E+11 | 1.24E+11 | 3.37E+10 |
| 10 | 196.1 | 9.88E+11 | 5.24E+11 | 3.65E+11 | 9.88E+10 |
| 5 | 385.0 | 1.94E+12 | 1.03E+12 | 7.17E+11 | 1.94E+11 |

† See Figure 17 load duration curve.

**Table 28. *E. coli* TMDL for WBID 0421 impaired segment watershed over a range of flow conditions – Missouri only**

| *Percentile Flow Exceedance* | *Flow (cfs)* | *Targets Based on Geometric Mean* | | | |
|---|---|---|---|---|---|
| | | *TMDL (counts/day)* | *Sum WLA (counts/day)* | *LA (counts/day)* | *MOS (counts/day)* |
| 95 | 2.7 | 1.18E+10 | 9.26E+09 | 1.18E+09 | 1.35E+09 |
| 90 | 3.2 | 1.39E+10 | 1.10E+10 | 1.39E+09 | 1.59E+09 |
| 70 | 6.0 | 2.67E+10 | 2.10E+10 | 2.66E+09 | 3.05E+09 |
| 50 | 10.7 | 4.71E+10 | 3.70E+10 | 4.70E+09 | 5.38E+09 |
| 30 | 19.7 | 8.69E+10 | 6.83E+10 | 8.68E+09 | 9.94E+09 |
| 10 | 57.9 | 2.55E+11 | 2.01E+11 | 2.55E+10 | 2.92E+10 |
| 5 | 113.7 | 5.01E+11 | 3.94E+11 | 5.00E+10 | 5.73E+10 |

**Table 29. *E. coli* WLA for WBID 0421 over a range of flow conditions – Wasteload allocations for Missouri designated MS4s and CSOs**

| *Percentile Flow Exceedance* | *Targets Based on Geometric Mean* | | | | |
|---|---|---|---|---|---|
| | *CSO** (counts/day)* | *Kansas City MS4 (counts/day)* | *Grandview MS4 (counts/day)* | *Raytown MS4* (counts/day)* | *Belton MS4 (counts/day)* |
| 95 | 0 | 7.13E+09 | 1.31E+09 | 0 | 8.12E+08 |
| 90 | 0 | 8.44E+09 | 1.55E+09 | 0 | 9.61E+08 |
| 70 | 0 | 1.61E+10 | 2.96E+09 | 0 | 1.84E+09 |
| 50 | 0 | 2.85E+10 | 5.22E+09 | 0 | 3.25E+09 |
| 30 | 0 | 5.26E+10 | 9.64E+09 | 0 | 6.00E+09 |
| 10 | 0 | 1.55E+11 | 2.83E+10 | 0 | 1.76E+10 |
| 5 | 0 | 3.04E+11 | 5.56E+10 | 0 | 3.46E+10 |

* MS4 entity not represented in the WBID 0421 impaired segment watershed.

** No CSOs in the WBID 0421 impaired segment watershed.

# 8 Load Allocation (Nonpoint Source Load)

The load allocation is the allowable amount of the pollutant load that can be assigned to nonpoint sources and includes all existing and future nonpoint sources, as well as natural background contributions [40 CFR § 130.2(g)]. A review of land cover and aerial imagery shows that nonpoint sources within the Missouri side of the Blue River watershed currently includes agricultural lands, diffuse rural residential housing, and developed industrial areas outside of the municipal boundaries. Essentially all urban stormwater runoff within the watershed is regulated by MS4 permits and, as noted above, is considered a point source. Since only about 6 percent of the Blue River watershed in Missouri falls outside of the designated MS4 area, load allocations assigned to nonpoint sources are relatively low (zero in subwatersheds for impaired segments 0419 and 0420 in Missouri) when compared to point source wasteload allocations (see tables above). It should be noted that, as with point sources, nonpoint source loads contributed by the Kansas portion of the watershed are not considered to cause or contribute to the impairment, and in order to meet TMDL targets in Missouri it must be assumed that Missouri's water quality standards are met at the state line.

# 9 Margin of Safety

A margin of safety is required in the TMDL calculation to account for uncertainties in scientific and technical understanding of water quality in natural systems. The margin of safety is intended to account for such uncertainties in a conservative manner. Based on EPA guidance, the margin of safety can be achieved through one of two approaches:

(1) Explicit - Reserve a portion of the loading capacity as a separate term in the TMDL.
(2) Implicit - Incorporate the margin of safety as part of the critical conditions for the wasteload allocation and the load allocation calculations by making conservative assumptions in the analysis.

The margin of safety for these TMDLs is an explicit 10 percent as shown in Tables 14 through 26. Furthermore, bacterial decay or die off was not accounted for in the establishment of these TMDLs. This conservative assumption provides an additional implicit margin of safety.

# 10 Seasonal Variation

Federal regulations at 40 CFR §130.7(c)(1) require that TMDLs take into consideration seasonal variation in applicable standards. Missouri's water quality criteria for the protection of whole body contact recreation are applicable during the recreational season, defined as being from April 1 to October 31. However, the Blue River and Indian Creek TMDLs take seasonal variation into account through the use of load duration curves, which represent the allowable pollutant load across all seasons and under all flow conditions, including critical conditions. For this reason, the *E. coli* targets and allocations found in this TMDL will be protective throughout the recreational season. The results obtained using the load duration curve method are more robust and reliable over all flows and seasons when compared with those obtained under single-flow critical conditions.

# 11 Monitoring Plans

The Department has not scheduled post-TMDL monitoring for Blue River and Indian Creek. Post-TMDL monitoring is often scheduled and carried out by the Department approximately three years after the approval of the TMDL or in a reasonable time period following completion of permit compliance schedules and the application of new effluent limits. The Department will also routinely examine physical habitat, water quality, invertebrate community, and fish community data collected by other local, state and federal entities in order to assess the effectiveness of TMDL implementation. In addition, certain quality-assured data collected by universities, municipalities, private companies and volunteer groups may potentially be considered for monitoring water quality following TMDL implementation.

In the case of Blue River and Indian Creek, monitoring is scheduled to be conducted in accordance with the post-construction monitoring plan contained within the Overflow Control Plan. This plan outlines efforts to monitor and measure the effectiveness of the Overflow

Control Plan throughout the course of implementation, including before, during, and after completion of individual projects. The monitoring plan includes a water quality monitoring component that will focus on parameters, such as *E. coli*, related to concerns from combined sewer overflow discharges and upstream pollutant sources; it also includes measures to evaluate the effectiveness of combined sewer overflow controls, and other infrastructure projects aimed at wet-weather control (Kansas City 2009). The plan is mandated as part of the consent decree between Kansas City and EPA, and will be conducted in accordance with the Overflow Control Plan's Quality Assurance Project Plan. Water quality monitoring data may include those collected by the USGS, KDHE, and the Department. In turn, the Department may use this data to evaluate whether or not Blue River and Indian Creek meet Missouri's water quality standards and can be removed from the 303(d) List of impaired waters.

# 12 Implementation Plans

States are not required under Section 303(d) of the Clean Water Act to develop TMDL implementation plans and EPA does not approve or disapprove them. However, the Department will develop and make available for public comment a separate implementation plan to be established in conjunction with this TMDL. The implementation plan will provide additional detailed information regarding how point and nonpoint sources can or should be controlled to ensure that implementation efforts achieve the pollutant allocations identified in this TMDL.

Point source reductions are typically implemented with discharge permits administered through the Missouri State Operating Permit program in order to meet the requirements of Missouri's water quality standards and the National Pollutant Discharge Elimination System. In the case of combined sewer overflows and sanitary sewer overflows discussed in this TMDL, implementation should be completed in accordance with the Overflow Control Plan developed by the Kansas City Water Services Department, and with the consent decree established as part of the civil action *United States of America v. The City of Kansas City, Missouri*, No. 4:10-cv-0497-GAF. This consent decree was lodged with the U.S. District Court for the Western District of Missouri on May 18, 2010, and is incorporated by reference into the current Missouri State Operating Permit for the Kansas City Blue River Wastewater Treatment Facility. Point source reductions may also be implemented by establishing or enhancing stormwater controls within each of the four MS4 permits within the Missouri portion of the Blue River watershed. Such controls not only address pollutants that may be contributed by urban runoff, but may also have an impact on the volume and frequency of sewer overflows.

Because the Department does not regulate nonpoint sources, nonpoint source loading is typically reduced through the use of best management practices, or BMPs, that may be implemented to address and improve land use practices that may contribute bacteria to the impaired water body. Grant money from the Department's Section 319 Nonpoint Source Implementation Program may also be available for implementing nonpoint source controls in the watershed. It should be noted that nonpoint sources for Section 319 purposes may vary from what is presented in this TMDL. For example, urban runoff regulated by an MS4 permit is considered a point source for TMDL purposes, but in some instances can be considered a nonpoint source for Section 319 purposes.

This TMDL establishes the allowable bacteria loadings that each impaired segment of Blue River and Indian Creek can receive without violating water quality standards. Therefore, the TMDL provides a basis for establishing appropriate point and nonpoint source pollutant controls (EPA 2001). Any management practices already in place or being developed in the watershed to eliminate the impairment will be included in the TMDL implementation plan. These may include actions required as part of an operating permit, a watershed management plan, or the Overflow Control Plan. Table 30 presents the needed load reductions to successfully implement this TMDL and meet water quality standards under all flow conditions.

**Table 30. Load reductions needed to meet water quality standards***

| *WB Segment* | *Percentile Flow Exceedance* | *Flow (cfs)* | *Observed Load (counts/day)* | *TMDL (counts/day)* | *Load Reduction (counts/day)* | *Percent Reduction (%)* |
|---|---|---|---|---|---|---|
| Blue River | 95 | 22.5 | 8.45E+10 | 1.13E+11 | -2.87E+10 | 0.0% |
| | 75 | 44.6 | 3.62E+11 | 2.25E+11 | 1.37E+11 | 37.92% |
| | 50 | 89.8 | 7.70E+11 | 4.52E+11 | 3.17E+11 | 41.21% |
| | 25 | 198.7 | 7.10E+12 | 1.00E+12 | 6.10E+12 | 85.90% |
| | 5 | 955.7 | 2.13E+14 | 4.82E+12 | 2.08E+14 | 97.74% |
| 0417 | 95 | 0.6 | 1.26E+10 | 2.97E+09 | 9.64E+09 | 76.5% |
| | 75 | 1.2 | 1.80E+10 | 5.89E+09 | 1.21E+10 | 67.3% |
| | 50 | 2.4 | 3.69E+11 | 1.19E+10 | 3.57E+11 | 96.8% |
| | 25 | 5.2 | 1.08E+11 | 2.63E+10 | 8.22E+10 | 75.8% |
| | 5 | 25.1 | No data | 1.26E+11 | -- | -- |
| 0418 | 95 | 4.7 | 2.66E+10 | 2.36E+10 | 2.98E+09 | 11.2% |
| | 75 | 9.3 | 1.07E+11 | 4.68E+10 | 6.00E+10 | 56.2% |
| | 50 | 18.7 | 1.82E+11 | 9.43E+10 | 8.75E+10 | 48.1% |
| | 25 | 41.1 | 2.32E+12 | 2.09E+11 | 2.11E+12 | 91.0% |
| | 5 | 199.2 | 4.84E+13 | 1.00E+12 | 4.74E+13 | 97.9% |
| 0419 | 95 | 1.9 | 3.28E+09 | 5.95E+09 | -2.67E+09 | 0.0% |
| | 75 | 3.8 | 1.99E+10 | 1.18E+10 | 8.09E+09 | 40.7% |
| | 50 | 7.7 | 5.87E+10 | 2.38E+10 | 3.49E+10 | 59.5% |
| | 25 | 17.1 | 8.91E+11 | 5.26E+10 | 8.38E+11 | 94.1% |
| | 5 | 82.1 | 1.43E+13 | 2.53E+11 | 1.41E+13 | 98.2% |
| 0420 | 95 | 6.2 | 4.73E+10 | 1.91E+10 | 2.82E+10 | 59.6% |
| | 75 | 12.3 | 1.33E+11 | 3.80E+10 | 9.39E+10 | 71.2% |
| | 50 | 24.8 | 1.74E+11 | 7.65E+10 | 9.70E+10 | 55.9% |
| | 25 | 54.9 | 1.38E+12 | 1.69E+11 | 1.21E+12 | 87.7% |
| | 5 | 264.3 | 7.56E+13 | 8.15E+11 | 7.47E+13 | 98.9% |
| 0421 | 95 | 9.0 | 4.42E+09 | 4.56E+10 | -4.12E+10 | 0.0% |
| | 75 | 18.0 | 9.94E+10 | 9.05E+10 | 8.93E+09 | 9.0% |
| | 50 | 36.2 | 1.82E+11 | 1.82E+11 | -4.97E+08 | 0.0% |
| | 25 | 80.1 | 2.47E+12 | 4.04E+11 | 2.07E+12 | 83.7% |
| | 5 | 385.05 | 8.86E+13 | 1.94E+12 | 8.67E+13 | 97.8% |

*Based on geomeans of observed data within a specific flow condition (i.e., high flows, moist conditions, etc.)

This implementation plan will focus on the Missouri portion of the watershed, where the state of Missouri has both regulatory authority and the potential to work with nonpoint source

stakeholders. However, it is estimated within the Overflow Control Plan that approximately 61 percent of the total *E. coli* loading in Blue River comes from sources other than the city's combined sewer outfalls, and can be attributed in part to upstream sources (Kansas City 2009). Therefore, any implementation plan must also recognize efforts that have been established by the state of Kansas to reduce point and nonpoint sources of pollutants, and must also address ways in which Missouri and Kansas can work cooperatively to implement future pollutant reductions.

# 13 Reasonable Assurance

Section 303(d)(1)(C) of the federal Clean Water Act requires that TMDLs be established at a level necessary to implement applicable water quality standards. As part of the TMDL process, consideration must be given to the assurances that point and nonpoint source allocations will be achieved and water quality standards attained. Where TMDLs are developed for waters impaired by point sources only, reasonable assurance is derived from the NPDES permitting program through discharge permits issued with effluent limits as stringent as necessary to meet water quality standards [CWA Section 301(b)(1)(C)]. For impaired waters, these discharge permits must be issued so that effluent limits are consistent with the assumptions and requirements of approved TMDL wasteload allocations [40 CFR 122.44(d)(1)(vii)(B)]. The Department has the authority to issue and enforce Missouri State Operating Permits for point source discharges. Inclusion of effluent limits in a state operating permit and requiring that effluent and instream monitoring be reported to the Department should provide reasonable assurance that instream WQS will be met.

Where a TMDL is developed for waters impaired by both point and nonpoint sources, point source wasteload allocations must be stringent enough so that in conjunction with the water body's other loadings (i.e., nonpoint sources) water quality standards are met. This generally occurs when the TMDL's combined nonpoint source load allocations and point source wasteload allocations do not exceed the water quality standards-based loading capacity and there is reasonable assurance that the TMDL's allocations can be achieved. Reasonable assurance that nonpoint sources will meet their allocated amount in the TMDL is dependent upon the availability and implementation of nonpoint source pollutant reduction plans, controls or BMPs within the watershed. If BMPs or other nonpoint source pollution controls make more stringent load allocations practicable, then wasteload allocations can be made less stringent. Thus, the TMDL process provides for nonpoint source control tradeoffs [40 CFR 130.2(i)]. When a demonstration of nonpoint source reasonable assurance is developed and approved for an impaired water body, additional pollutant allocations for point sources may be allowed provided water quality standards are still attained. When a demonstration of nonpoint source reasonable assurance does not exist, or it is determined that nonpoint source pollutant reduction plans, controls or BMPs are not feasible, durable, or will not result in the required load reductions, allocation of greater pollutant loading to point sources cannot occur. Any discussion of detailed efforts relating to point and nonpoint source reductions will be found in the supplemental implementation plan to be developed by the Department following the recommendations found in Section 12 of this document.

A variety of grants and loans may be available to assist watershed stakeholders with developing and implementing watershed plans, controls and practices to meet the required wasteload and load allocations in the TMDL and demonstrate reasonable assurance.

## 14 Public Participation

The water quality-limited segments of Blue River and Indian Creek addressed with this TMDL are included on Missouri's 2010 303(d) List of impaired waters. EPA regulations require that TMDLs be subject to public review [40 CFR 130.7]. Before finalizing the Blue River and Indian Creek TMDL the public has been notified of a 45 day comment period. Public notices to comment on the draft Blue River and Indian Creek TMDL have been distributed via postal mail or e-mail to major stakeholders in the watershed, and other potentially impacted parties. Groups that received the public notice announcement include the Missouri Clean Water Commission; the Department's Water Quality Coordinating Committee; the Missouri Department of Conservation's Policy Coordinating Unit; the Cass County and Jackson County (Mo.) Soil and Water Conservation Districts; the Kansas City Water Services Department; the public works departments for the cities of Grandview, Raytown, and Belton; city clerks for these cities; the Cass County Planning, Environmental, Flood Plain and Solid Waste Dept.; the Cass County and Jackson County Commissions; the Mid-America Regional Council; the Blue River Watershed Association; Bridging the Gap; the Missouri Coalition for the Environment; the Missouri stream Team Watershed Coalition; the roughly 200 Stream Team volunteers living in or near the watershed; and the 18 Missouri state legislators representing areas within the watersheds. In addition, since Blue River and Indian Creek originate in Kansas and flow into Missouri, a public notice announcement was also sent to the Kansas Department of Health and Environment, Bureau of Water; Johnson County (Kan.) Wastewater; and Johnson County Infrastructure and Transportation. Announcement of the public notice period for this TMDL was also issued as a press release to local media outlets in the proximity of the Blue River and Indian Creek watersheds. Finally, the public notice, the TMDL Information Sheet, and this TMDL document have been posted on the Department's TMDL webpage at dnr.mo.gov/env/wpp/tmdl/wpc-tmdl-progress.htm, making them available to anyone with Internet access. Any comments received, and the Department's response to those comments, will be placed in the Blue River and Indian Creek TMDL administrative record, as noted below, and on the TMDL webpage.

## 15 Administrative Record and Supporting Documentation

An administrative record on the Blue River and Indian Creek TMDL has been assembled and is being kept on file with the Missouri Department of Natural Resources. It includes any plans, studies, data and calculations on which the TMDL is based, as well as the TMDL Information Sheet, the public notice announcement, and any public comments received. This information is available upon request to the Department at dnr.mo.gov/sunshine-form.htm. Any request for information on this TMDL will be processed in accordance with Missouri's Sunshine Law (Chapter 610, RSMO) and the Department's administrative policies and procedures governing Sunshine Law requests. For more information on open record/Sunshine requests, please consult the Department's website at dnr.mo.gov/sunshinerequests.htm.

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# Appendix A

## Blue River and Indian Creek *E. coli* data

| Sampling Organization[1] | Site Description | WBID | UTM Easting | UTM Northing | Sampling Date | *E. coli* (#/100mL) | Flow (cfs) |
|---|---|---|---|---|---|---|---|
| USGS | Blue R. at 12th Street | 0417 | 370842 | 4328203 | 9/9/1998 | 540.0 | 70.0 |
| USGS | Blue R. at 12th Street | 0417 | 370842 | 4328203 | 10/15/1998 | 400.0 | 142.0 |
| USGS | Blue R. at 12th Street | 0417 | 370842 | 4328203 | 12/9/1998 | 6100.0 | 415.0 |
| USGS | Blue R. at 12th Street | 0417 | 370842 | 4328203 | 1/27/1999 | 970.0 | 51.0 |
| USGS | Blue R. at 12th Street | 0417 | 370842 | 4328203 | 2/18/1999 | 1010.0 | 224.0 |
| USGS | Blue R. at 12th Street | 0417 | 370842 | 4328203 | 5/10/1999 | 700.0 | 249.0 |
| USGS | Blue R. at 12th Street | 0417 | 370842 | 4328203 | 6/18/1999 | 10500.0 | 155.0 |
| USGS | Blue R. at 12th Street | 0417 | 370842 | 4328203 | 8/19/1999 | 530.0 | 41.0 |
| USGS | Blue R. at 12th Street | 0417 | 370842 | 4328203 | 10/14/1999 | 350.0 | 31.0 |
| USGS | Blue R. at 12th Street | 0417 | 370842 | 4328203 | 12/21/1999 | 1550.0 | 60.0 |
| USGS | Blue R. at 12th Street | 0417 | 370842 | 4328203 | 2/15/2000 | 0.499 | 30.0 |
| USGS | Blue R. at 12th Street | 0417 | 370842 | 4328203 | 4/11/2000 | 1300.0 | 34.0 |
| USGS | Blue R. at 12th Street | 0417 | 370842 | 4328203 | 6/30/2000 | 2200.0 | 68.0 |
| USGS | Blue R. at 12th Street | 0417 | 370842 | 4328203 | 8/22/2000 | 5500.0 | 30.0 |
| USGS | Blue R. at 12th Street | 0417 | 370842 | 4328203 | 10/11/2000 | 2600.0 | 36.0 |
| USGS | Blue R. at 12th Street | 0417 | 370842 | 4328203 | 10/31/2001 | 180.0 | 29.0 |
| USGS | Blue R. at 12th Street | 0417 | 370842 | 4328203 | 12/11/2001 | 460.0 | 41.0 |
| USGS | Blue R. at 12th Street | 0417 | 370842 | 4328203 | 3/14/2002 | 170.0 | 66.0 |
| USGS | Blue R. at 12th Street | 0417 | 370842 | 4328203 | 6/20/2002 | 310.0 | 48.0 |
| USGS | Blue R. at 12th Street | 0417 | 370842 | 4328203 | 8/6/2002 | 285.0 | 31.0 |
| USGS | Blue R. at 12th Street | 0417 | 370842 | 4328203 | 11/7/2002 | 1500.0 | 47.0 |
| USGS | Blue R. at 12th Street | 0417 | 370842 | 4328203 | 2/12/2003 | 200.0 | 24.0 |
| USGS | Blue R. @ RR bridge nr. Scarritt Ave. | 0417 | 370415 | 4330546 | 9/10/2004 | 9600.0 | 30.0 |
| USGS | Blue R. 900 ft. ab. Mouth | 0417 | 373267 | 4331571 | 9/15/2004 | 2600.0 | 30.0 |
| USGS | Blue R. 900 ft. ab. Mouth | 0417 | 373267 | 4331571 | 5/5/2005 | 860.0 | 55.0 |
| USGS | Blue R. @ RR bridge nr. Scarritt Ave. | 0417 | 370415 | 4330546 | 5/5/2005 | 2850 | 50.0 |
| USGS | Blue R. 900 ft. ab. Mouth | 0417 | 373267 | 4331571 | 8/2/2005 | 160.0 | 45.0 |
| USGS | Blue R. @ RR bridge nr. Scarritt Ave. | 0417 | 370415 | 4330546 | 8/2/2005 | 2100.0 | 40.0 |
| USGS | Blue R. 0.6 mi.ab. Brush Cr. @ Blue Parkway | 0418 | 367853 | 4321714 | 9/9/1998 | 660.0 | 37.0 |
| USGS | Blue R. 0.6 mi.ab. Brush Cr. @ Blue Parkway | 0418 | 367853 | 4321714 | 10/14/1998 | 190.0 | 126.0 |
| USGS | Blue R. 0.6 mi.ab. Brush Cr. @ Blue Parkway | 0418 | 367853 | 4321714 | 12/9/1998 | 4600.0 | 323.0 |
| USGS | Blue R. 0.6 mi.ab. Brush Cr. @ Blue Parkway | 0418 | 367853 | 4321714 | 1/21/1999 | 240.0 | 64.0 |
| USGS | Blue R. 0.6 mi.ab. Brush Cr. @ Blue Parkway | 0418 | 367853 | 4321714 | 2/22/1999 | 1400.0 | 198.0 |
| USGS | Blue R. 0.6 mi.ab. Brush Cr. @ Blue Parkway | 0418 | 367853 | 4321714 | 5/7/1999 | 3200.0 | 331.0 |
| USGS | Blue R. 0.6 mi.ab. Brush Cr. @ Blue Parkway | 0418 | 367853 | 4321714 | 6/15/1999 | 2000.0 | 67.0 |
| USGS | Blue R. 0.6 mi.ab. Brush Cr. @ Blue Parkway | 0418 | 367853 | 4321714 | 8/19/1999 | 940.0 | 39.0 |

[1] USGS = U.S. Geological Survey; KDHE = Kansas Department of Health and Environment; USEPA-7 = U.S. Environmental Protection Agency Region 7

| Sampling Organization[1] | Site Description | WBID | UTM Easting | UTM Northing | Sampling Date | *E. coli* (#/100mL) | Flow (cfs) |
|---|---|---|---|---|---|---|---|
| USGS | Blue R. 0.6 mi.ab. Brush Cr. @ Blue Parkway | 0418 | 367853 | 4321714 | 10/13/1999 | 4000.0 | 36.0 |
| USGS | Blue R. 0.6 mi.ab. Brush Cr. @ Blue Parkway | 0418 | 367853 | 4321714 | 12/17/1999 | 150.0 | 58.0 |
| USGS | Blue R. 0.6 mi.ab. Brush Cr. @ Blue Parkway | 0418 | 367853 | 4321714 | 2/14/2000 | 450.0 | 32.0 |
| USGS | Blue R. 0.6 mi.ab. Brush Cr. @ Blue Parkway | 0418 | 367853 | 4321714 | 4/11/2000 | 1800.0 | 37.0 |
| USGS | Blue R. 0.6 mi.ab. Brush Cr. @ Blue Parkway | 0418 | 367853 | 4321714 | 6/29/2000 | 920.0 | 20.0 |
| USGS | Blue R. 0.6 mi.ab. Brush Cr. @ Blue Parkway | 0418 | 367853 | 4321714 | 8/22/2000 | 510.0 | 24.0 |
| USGS | Blue R. 0.6 mi.ab. Brush Cr. @ Blue Parkway | 0418 | 367853 | 4321714 | 10/11/2000 | 750.0 | 30.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 6/2/2003 | 8800.0 | 1830.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 6/11/2003 | 4800.0 | 500.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 6/29/2003 | 5100.0 | 481.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 7/8/2003 | 79.0 | 26.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 7/9/2003 | 18000.0 | 550.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 8/19/2003 | 49.0 | 19.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 9/11/2003 | 22000.0 | 520.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 12/2/2003 | 74.0 | 42.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 4/8/2004 | 16.0 | 86.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 5/25/2004 | 17200.0 | 2816.0 |
| USGS | Blue R. 0.8 mi. bl. Brush Cr. | 0418 | 369109 | 4322797 | 9/10/2004 | 276.0 | 77.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 9/10/2004 | 506.0 | 83.0 |
| USGS | Blue R. 0.8 mi. bl. Brush Cr. | 0418 | 369109 | 4322797 | 5/4/2005 | 61.0 | 40.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 5/4/2005 | 65.0 | 47.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 5/13/2005 | 2900.0 | 3105.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 6/1/2005 | 14000.0 | 1330.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 7/4/2005 | 11000.0 | 1340.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 7/26/2005 | 15000.0 | 768.0 |
| USGS | Blue R. 0.8 mi. bl. Brush Cr. | 0418 | 369109 | 4322797 | 8/2/2005 | 65.0 | 29.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 8/2/2005 | 170.0 | 37.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 10/6/2005 | 300.0 | 60.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 12/13/2005 | 440 | 89.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 3/29/2006 | 8.0 | 92.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 4/24/2006 | 23000.0 | 1110.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 4/28/2006 | 3900.0 | 685.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 6/6/2006 | 15000.0 | 1830.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 6/25/2006 | 19000.0 | 818.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 6/27/2006 | 230.0 | 68.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 11/2/2006 | 32.0 | 73.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 12/15/2006 | 43.0 | 78.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 2/24/2007 | 13000.0 | 1010.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 3/8/2007 | 18.0 | 180.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 3/29/2007 | 13000.0 | 868.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 4/26/2007 | 22000.0 | 1740.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 5/7/2007 | 46000.0 | 19400.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 8/8/2007 | 140.0 | 29.0 |
| USGS | Blue R. @ Stadium Dr. | 0418 | 369163 | 4324325 | 11/1/2007 | 71.0 | 58.0 |

| Sampling Organization[1] | Site Description | WBID | UTM Easting | UTM Northing | Sampling Date | *E. coli* (#/100mL) | Flow (cfs) |
|---|---|---|---|---|---|---|---|
| USEPA-7 | Blue River @ Coal Mine Rd. | 0418 | 368392 | 4322447 | 5/18/2010 | 250.0 | |
| USEPA-7 | Blue River @ Coal Mine Rd. | 0418 | 368392 | 4322447 | 5/26/2010 | 145.5 | |
| USEPA-7 | Blue River @ Coal Mine Rd. | 0418 | 368392 | 4322447 | 6/2/2010 | >2419.6 | |
| USEPA-7 | Blue River @ Coal Mine Rd. | 0418 | 368392 | 4322447 | 6/3/2010 | 1986.3 | |
| USEPA-7 | Blue River @ Coal Mine Rd. | 0418 | 368392 | 4322447 | 6/9/2010 | >24196.0 | |
| USEPA-7 | Blue River @ Coal Mine Rd. | 0418 | 368392 | 4322447 | 6/17/2010 | 30760.0 | |
| USEPA-7 | Blue River @ Coal Mine Rd. | 0418 | 368392 | 4322447 | 6/22/2010 | 378.4 | |
| USEPA-7 | Blue River @ Coal Mine Rd. | 0418 | 368392 | 4322447 | 6/24/2010 | 178.5 | |
| USEPA-7 | Blue River @ Coal Mine Rd. | 0418 | 368392 | 4322447 | 7/6/2010 | 11530.0 | |
| USEPA-7 | Blue River @ Coal Mine Rd. | 0418 | 368392 | 4322447 | 8/3/2010 | 149.7 | |
| USEPA-7 | Blue River @ Coal Mine Rd. | 0418 | 368392 | 4322447 | 8/17/2010 | 206.4 | |
| USEPA-7 | Blue River @ Coal Mine Rd. | 0418 | 368392 | 4322447 | 8/24/2010 | 328.2 | |
| USEPA-7 | Blue River @ Coal Mine Rd. | 0418 | 368392 | 4322447 | 9/8/2010 | 191.8 | |
| USEPA-7 | Blue River @ Coal Mine Rd. | 0418 | 368392 | 4322447 | 9/14/2010 | 12033.0 | |
| USEPA-7 | Blue River @ Coal Mine Rd. | 0418 | 368392 | 4322447 | 9/20/2010 | 261.3 | |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 8/20/1998 | 220.0 | 34.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 10/9/1998 | 120.0 | 270.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 12/3/1998 | 800.0 | 331.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 1/27/1999 | 640.0 | 41.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 2/22/1999 | 1400.0 | 108.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 5/6/1999 | 2700.0 | 581.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 6/10/1999 | 1000.0 | 39.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 7/21/1999 | 1680.0 | 37.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 10/13/1999 | 970.0 | 21.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 12/17/1999 | 75.0 | 43.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 2/14/2000 | 100.0 | 27.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 4/11/2000 | 740.0 | 23.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 6/29/2000 | 400.0 | 69.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 8/22/2000 | 170.0 | 21.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 10/11/2000 | 320.0 | 22.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 8/29/2001 | 540.0 | 60.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 10/31/2001 | 40.0 | 29.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 12/10/2001 | 20.0 | 30.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 3/14/2002 | 21.0 | 43.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 6/18/2002 | 2550.0 | 60.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 8/7/2002 | 0.499 | 25.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 11/5/2002 | 270.0 | 47.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 2/11/2003 | 16.0 | 24.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 4/23/2003 | 5500.0 | 832.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 4/24/2003 | 4600.0 | 439.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 5/9/2003 | 22000.0 | 1793.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 6/2/2003 | 8300.0 | 2463.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 7/8/2003 | 78.0 | 25.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 8/19/2003 | 100.0 | 20.0 |

| Sampling Organization[1] | Site Description | WBID | UTM Easting | UTM Northing | Sampling Date | *E. coli* (#/100mL) | Flow (cfs) |
|---|---|---|---|---|---|---|---|
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 11/25/2003 | 1700.0 | 38.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 4/7/2004 | 69.0 | 88.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 5/25/2004 | 32500.0 | 3306.0 |
| USGS | Blue River 1 mi.bl. Indian Cr. | 0419 | 365314 | 4314031 | 9/9/2004 | 226.0 | 84.0 |
| USGS | Blue R. @Bannister Road | 0419 | 364910 | 4313183 | 9/9/2004 | 365.0 | 87.0 |
| USGS | Blue River 1 mi.bl. Indian Cr. | 0419 | 365314 | 4314031 | 5/3/2005 | 83.0 | 40.0 |
| USGS | Blue R. @Bannister Road | 0419 | 364910 | 4313183 | 5/3/2005 | 140.0 | 40.0 |
| USGS | Blue R. bl. Gregory Blvd. | 0419 | 367727 | 4317825 | 5/4/2005 | 100.0 | 40.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 5/13/2005 | 2100.0 | 2140.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 5/13/2005 | 9900.0 | 2840.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 6/1/2005 | 22000.0 | 973.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 7/3/2005 | 24000.0 | 1510.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 7/26/2005 | 9800.0 | 672.0 |
| USGS | Blue R. bl. Gregory Blvd. | 0419 | 367727 | 4317825 | 8/1/2005 | 80 | 22.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 8/1/2005 | 210.0 | 21.0 |
| USGS | Blue River 1 mi.bl. Indian Cr. | 0419 | 365314 | 4314031 | 8/1/2005 | 270.0 | 22.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 10/6/2005 | 260.0 | 58.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 12/6/2005 | 28.0 | 39.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 3/29/2006 | 30.0 | 61.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 4/24/2006 | 24000.0 | 1020.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 4/28/2006 | 1000.0 | 402.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 4/28/2006 | 9400.0 | 576.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 6/5/2006 | 27000.0 | 1630.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 6/27/2006 | 210.0 | 51.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 11/2/2006 | 62.0 | 53.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 12/15/2006 | 220.0 | 76.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 2/24/2007 | 2400.0 | 754.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 3/3/2007 | 19000.0 | 666.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 3/8/2007 | 140.0 | 170.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 4/25/2007 | 36000.0 | 2830.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 5/7/2007 | 18000.0 | 12700.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 8/8/2007 | 120.0 | 25.0 |
| USGS | Blue R. @ Bannister Road | 0419 | 364910 | 4313183 | 11/1/2007 | 184.0 | 47.0 |
| USEPA-7 | Blue R. @ Minor Park Golf Course at path crossing | 0419 | 367903 | 4317322 | 5/26/2010 | 52.0 | |
| USEPA-7 | Blue R. @ Minor Park Golf Course at path crossing | 0419 | 367903 | 4317322 | 6/2/2010 | >2419.6 | |
| USEPA-7 | Blue R. @ Minor Park Golf Course at path crossing | 0419 | 367903 | 4317322 | 6/3/2010 | 686.7 | |
| USEPA-7 | Blue R. @ Minor Park Golf Course at path crossing | 0419 | 367903 | 4317322 | 6/9/2010 | 17329.0 | |
| USEPA-7 | Blue R. @ Minor Park Golf Course at path crossing | 0419 | 367903 | 4317322 | 6/17/2010 | 7701.0 | |
| USEPA-7 | Blue R. @ Minor Park Golf Course at path crossing | 0419 | 367903 | 4317322 | 6/22/2010 | 81.3 | |
| USEPA-7 | Blue R. @ Minor Park Golf Course at path crossing | 0419 | 367903 | 4317322 | 6/24/2010 | 62.7 | |
| USEPA-7 | Blue R. @ Minor Park Golf Course at path crossing | 0419 | 367903 | 4317322 | 7/6/2010 | 7670.0 | |
| USEPA-7 | Blue R. @ Minor Park Golf Course at path crossing | 0419 | 367903 | 4317322 | 7/8/2010 | 2613.0 | |
| USEPA-7 | Blue R. @ Minor Park Golf Course at path crossing | 0419 | 367903 | 4317322 | 8/3/2010 | 65.7 | |
| USEPA-7 | Blue R. @ Minor Park Golf Course at path crossing | 0419 | 367903 | 4317322 | 8/18/2010 | 52.9 | |

| Sampling Organization[1] | Site Description | WBID | UTM Easting | UTM Northing | Sampling Date | *E. coli* (#/100mL) | Flow (cfs) |
|---|---|---|---|---|---|---|---|
| USEPA-7 | Blue R. @ Minor Park Golf Course at path crossing | 0419 | 367903 | 4317322 | 8/24/2010 | 201.4 | |
| USEPA-7 | Blue R. @ Minor Park Golf Course at path crossing | 0419 | 367903 | 4317322 | 9/8/2010 | 39.3 | |
| USEPA-7 | Blue R. @ Minor Park Golf Course at path crossing | 0419 | 367903 | 4317322 | 9/14/2010 | 2382.0 | |
| USEPA-7 | Blue R. @Bannister Road | 0419 | 364910 | 4313183 | 9/20/2010 | 275.5 | |
| USGS | Indian Cr. upstrm. Of Indian Cr. WWTP, Kansas | 0420 | 350710 | 4308391 | 11/1/2001 | 65.0 | 1.4 |
| USGS | Indian Cr. just bl. Indian Cr. WWTP, Kansas. | 0420 | 352847 | 4309907 | 11/1/2001 | 270.0 | 10.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 11/1/2001 | 1200.0 | 20.0 |
| USGS | Indian Cr. upstrm. Of Indian Cr. WWTP, Kansas | 0420 | 350710 | 4308391 | 12/20/2001 | 42.0 | 0.83 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 12/20/2001 | 58.0 | 14.0 |
| USGS | Indian Cr. just bl. Indian Cr. WWTP, Kansas. | 0420 | 352847 | 4309907 | 12/20/2001 | 95.0 | 15.0 |
| USGS | Indian Cr. upstrm. Of Indian Cr. WWTP, Kansas | 0420 | 350710 | 4308391 | 3/21/2002 | 45.0 | 1.3 |
| USGS | Indian Cr. just bl. Indian Cr. WWTP, Kansas. | 0420 | 352847 | 4309907 | 3/21/2002 | 230.0 | 15.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 3/22/2002 | 0.499 | 32.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 6/19/2002 | 180.0 | 20.0 |
| USGS | Indian Cr. upstrm. Of Indian Cr. WWTP, Kansas | 0420 | 350710 | 4308391 | 6/19/2002 | 860.0 | 2.2 |
| USGS | Indian Cr. just bl. Indian Cr. WWTP, Kansas. | 0420 | 352847 | 4309907 | 6/19/2002 | 1100.0 | 14.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 8/6/2002 | 4600.0 | 21.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 11/7/2002 | 1100.0 | 36.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 2/12/2003 | 60.0 | 21.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 3/19/2003 | 740.0 | 171.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 4/19/2003 | 16000.0 | 1596.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 4/23/2003 | 3300.0 | 633.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 5/9/2003 | 30000.0 | 1468.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 6/2/2003 | 16000.0 | 1925.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 7/7/2003 | 200.0 | 20.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 8/18/2003 | 120.0 | 18.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 8/28/2003 | 170000.0 | 12811.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 8/31/2003 | 12000.0 | 7281.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 12/2/2003 | 35.0 | 23.0 |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 12/30/2003 | 144.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 1/8/2004 | 108.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 3/2/2004 | 262.0 | |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 4/13/2004 | 110.0 | 30.0 |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 5/6/2004 | 249.0 | |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 5/24/2004 | 41100.0 | 1163.0 |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 7/8/2004 | 92.0 | |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 9/3/2004 | 265.0 | 36.0 |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 9/9/2004 | 328.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 11/4/2004 | 6131.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 2/3/2005 | 272.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 4/7/2005 | 175.0 | |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 5/3/2005 | 73.0 | 20.0 |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 6/2/2005 | 1789.0 | |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 8/1/2005 | 220.0 | 22.0 |

| Sampling Organization[1] | Site Description | WBID | UTM Easting | UTM Northing | Sampling Date | *E. coli* (#/100mL) | Flow (cfs) |
|---|---|---|---|---|---|---|---|
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 8/4/2005 | 121.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 10/6/2005 | 161.0 | |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 10/11/2005 | 110.0 | 33.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 10/20/2005 | 1700.0 | 552.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 12/5/2005 | 70.0 | 20.0 |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 12/8/2005 | 166.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 1/5/2006 | 1850.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 3/9/2006 | 10462.0 | |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 3/29/2006 | 3700 | 29.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 4/28/2006 | 20000.0 | 534.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 4/29/2006 | 6750 | 1210.0 |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 5/4/2006 | 594.0 | |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 6/5/2006 | 2100.0 | 943.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 6/27/2006 | 350.0 | 28.0 |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 7/6/2006 | 305.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 9/7/2006 | 160.0 | |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 11/1/2006 | 19.0 | 34.0 |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 11/2/2006 | 4.99 | |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 12/14/2006 | 98.0 | 32.0 |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 2/8/2007 | 12033.0 | |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 2/24/2007 | 9900.0 | 398.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 3/7/2007 | 8400.0 | 52.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 3/30/2007 | 22000.0 | 473.0 |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 4/5/2007 | 836.0 | |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 4/25/2007 | 23000.0 | 949.0 |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 5/7/2007 | 24000.0 | 3080.0 |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 6/7/2007 | 216.0 | |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 8/8/2007 | 109.0 | 34.0 |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 8/9/2007 | 17853.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 10/4/2007 | 259.0 | |
| USGS | Indian Cr. Nr. State Line | 0420 | 360929 | 4311542 | 11/1/2007 | 218.0 | 27.0 |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 12/18/2007 | 148.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 1/9/2008 | 789.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 3/5/2008 | 20.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 5/7/2008 | 20.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 7/9/2008 | 1187.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 9/3/2008 | 3076.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 11/13/2008 | 134.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 2/4/2009 | 31.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 4/6/2009 | 20.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 6/3/2009 | 6488.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 8/25/2009 | 285.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 12/29/2009 | 148.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 1/13/2010 | 75.0 | |

| Sampling Organization[1] | Site Description | WBID | UTM Easting | UTM Northing | Sampling Date | *E. coli* (#/100mL) | Flow (cfs) |
|---|---|---|---|---|---|---|---|
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 4/28/2010 | 63.0 | |
| KDHE | Indian Cr. @ State Line Bridge | 0420 | 360619 | 4311193 | 7/26/2010 | 530.0 | |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 8/29/2001 | 380.0 | 7.5 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 10/31/2001 | 300.0 | 6.8 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 12/11/2001 | 20.0 | 4.7 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 3/13/2002 | 100.0 | 5.8 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 6/18/2002 | 7600.0 | 20.0 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 8/7/2002 | 0.499 | 2.8 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 11/5/2002 | 80.0 | 11.0 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 2/11/2003 | 5.0 | 3.6 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 5/11/2003 | 17000.0 | 482.0 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 6/1/2003 | 5900.0 | 150.0 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 6/3/2003 | 23000.0 | 167.0 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 6/11/2003 | 18000.0 | 262.0 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 7/7/2003 | 45.0 | 3.6 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 8/18/2003 | 43.0 | 3.5 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 8/30/2003 | 7400.0 | 141.0 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 8/31/2003 | 24000.0 | 3776.0 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 11/25/2003 | 140.0 | 8.4 |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 12/30/2003 | 97.0 | |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 1/8/2004 | 4.99 | |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 3/2/2004 | 4.99 | |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 4/8/2004 | 34.0 | 44.0 |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 5/6/2004 | 20.0 | |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 5/25/2004 | 15700.0 | 1780.0 |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 7/8/2004 | 175.0 | |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 9/3/2004 | 250.0 | 34.0 |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 9/9/2004 | 609.0 | |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 11/4/2004 | 12033.0 | |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 2/3/2005 | 10.0 | |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 4/7/2005 | 52.0 | |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 5/3/2005 | 120.0 | 12.0 |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 6/2/2005 | 41.0 | |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 8/1/2005 | 32.0 | 5.0 |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 8/4/2005 | 10.0 | |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 10/6/2005 | 240.0 | 29.0 |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 10/6/2005 | 441.0 | |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 12/6/2005 | 5.0 | 11.0 |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 12/8/2005 | 10.0 | |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 1/5/2006 | 10.0 | |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 3/9/2006 | 20.0 | |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 3/29/2006 | 18.0 | 22.0 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 4/24/2006 | 17000.0 | 395.0 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 4/29/2006 | 1500.0 | 208.0 |

| Sampling Organization[1] | Site Description | WBID | UTM Easting | UTM Northing | Sampling Date | *E. coli* (#/100mL) | Flow (cfs) |
|---|---|---|---|---|---|---|---|
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 5/4/2006 | 271.0 | |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 6/5/2006 | 18000.0 | 874.0 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 6/27/2006 | 250.0 | 16.0 |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 7/6/2006 | 52.0 | |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 7/11/2006 | 16000.0 | 1070.0 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 7/12/2006 | 20000.0 | 1490.0 |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 9/7/2006 | 121.0 | |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 11/1/2006 | 67.0 | 23.0 |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 11/2/2006 | 173.0 | |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 12/14/2006 | 39.0 | 29.0 |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 2/8/2007 | 4.99 | |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 2/24/2007 | 300.0 | 362.0 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 3/7/2007 | 15.0 | 61.0 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 3/30/2007 | 590.0 | 240.0 |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 4/5/2007 | 404.0 | |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 4/25/2007 | 11000.0 | 972.0 |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 5/7/2007 | 48000.0 | 6080.0 |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 6/7/2007 | 158.0 | |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 8/8/2007 | 52.0 | 7.0 |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 8/9/2007 | 1014.0 | |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 10/4/2007 | 75.0 | |
| USGS | Blue R. 6.6 mi.ab.Indian Cr. @ Blue Ridge Blvd | 0421 | 362908 | 4305691 | 11/1/2007 | 45.0 | 17.0 |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 12/18/2007 | 210 | |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 1/9/2008 | 148.0 | |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 3/5/2008 | 41.0 | |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 5/7/2008 | 156.0 | |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 7/9/2008 | 620.0 | |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 9/3/2008 | 146.0 | |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 11/13/2008 | 246.0 | |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 2/4/2009 | 4.99 | |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 4/6/2009 | 63.0 | |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 6/3/2009 | 2909.0 | |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 8/25/2009 | 197.0 | |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 12/29/2009 | 31.0 | |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 1/13/2010 | 4.99 | |
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 4/28/2010 | 231.0 | |
| USEPA-7 | Blue R. 3.0 mi.ab. Indian Cr. | 0421 | 363800 | 4309661 | 6/2/2010 | >2419.6 | |
| USEPA-7 | Blue R. 3.0 mi.ab. Indian Cr. | 0421 | 363800 | 4309661 | 6/3/2010 | >2419.6 | |
| USEPA-7 | Blue R. 3.0 mi.ab. Indian Cr. | 0421 | 363800 | 4309661 | 6/9/2010 | >24196.0 | |
| USEPA-7 | Blue R. 3.0 mi.ab. Indian Cr. | 0421 | 363800 | 4309661 | 6/17/2010 | 630.0 | |
| USEPA-7 | Blue R. 3.0 mi.ab. Indian Cr. | 0421 | 363800 | 4309661 | 6/22/2010 | 517.2 | |
| USEPA-7 | Blue R. 3.0 mi.ab. Indian Cr. | 0421 | 363800 | 4309661 | 6/24/2010 | 344.8 | |
| USEPA-7 | Blue R. 3.0 mi.ab. Indian Cr. | 0421 | 363800 | 4309661 | 7/6/2010 | 18500.0 | |
| USEPA-7 | Blue R. 3.0 mi.ab. Indian Cr. | 0421 | 363800 | 4309661 | 7/8/2010 | 2909.0 | |

| Sampling Organization[1] | Site Description | WBID | UTM Easting | UTM Northing | Sampling Date | *E. coli* (#/100mL) | Flow (cfs) |
|---|---|---|---|---|---|---|---|
| KDHE | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 7/26/2010 | 1245.0 | |
| USEPA-7 | Blue R. 3.0 mi.ab. Indian Cr. | 0421 | 363800 | 4309661 | 8/3/2010 | 307.6 | |
| USEPA-7 | Blue R. 3.0 mi.ab. Indian Cr. | 0421 | 363800 | 4309661 | 8/18/2010 | 186.0 | |
| USEPA-7 | Blue R. 3.0 mi.ab. Indian Cr. | 0421 | 363800 | 4309661 | 8/24/2010 | 866.4 | |
| USEPA-7 | Blue R. 3.0 mi.ab. Indian Cr. | 0421 | 363800 | 4309661 | 9/8/2010 | 204.6 | |
| USEPA-7 | Blue R. 3.0 mi.ab. Indian Cr. | 0421 | 363800 | 4309661 | 9/14/2010 | 11199.0 | |
| USEPA-7 | Blue R. 3 mi. SE of Stanley | 0421 | 360057 | 4300512 | 9/20/2010 | 191.8 | |

## Appendix A Notes:

These data are of sufficient quality to evaluate compliance with water quality standards and to support TMDL development because they were collected in accordance with required quality assurance procedures and Department sampling protocols.

Detection limits and non-detects are expressed as "less-than" numbers and show up in this table as those data ending in 99. Example: <1 will appear as 0.499.

Numbers expressed in this table as “greater-than” values (>) are retained as such in this table, but are doubled for calculation purposes, in keeping with the Department’s assessment methodology.

An empty cell means no data available.

# Appendix B

## Missouri General (MOG) and Storm Water (MOR) Permits in the Blue River and Indian Creek Watersheds

| Permit No. | Facility Name | Receiving Stream | Permit Type | Permit Expiration Date |
|---|---|---|---|---|
| MO-G490239 | LaFarge North America-8 | Blue River | General | 10/5/2016 |
| MO-G490243 | Derbigium Americas, Inc. | Tributary to Brush Creek | General | 10/5/2016 |
| MO-G490259 | Superior Bowen Asphalt Co. | Tributary to Blue River | General | 10/5/2016 |
| MO-G490447 | KC Wilbert Vault | Tributary to Kernoodle Lakes | General | 10/5/2016 |
| MO-G490522 | Vance Brothers, Inc. | Tributary to Blue River | General | 10/5/2016 |
| MO-G490523 | Fordyce Concrete Co. | Blue River | General | 10/5/2016 |
| MO-G490576 | Vance Brothers, Inc. | Blue River | General | 10/5/2016 |
| MO-G490577 | Superior Bowen Asphalt Co. | Tributary to Blue River | General | 10/5/2016 |
| MO-G490580 | Allied Concrete Products | Tributary to Blue River | General | 10/5/2016 |
| MO-G490668 | J.M. Fahey Construction | Brush Creek | General | 10/5/2016 |
| MO-G490695 | Miller, an Oldcastle Co. | Tributary to Blue River | General | 10/5/2016 |
| MO-G490860 | Bledsoe's Rental Co. | Tributary to Blue River | General | 10/5/2016 |
| MO-G490914 | Penny's Concrete, Inc. | Tributary to Blue River | General | 10/5/2016 |
| MO-G490915 | Damon Pursell Construction Co. | Tributary to Blue River | General | 10/5/2016 |
| MO-G491040 | All American Redi-mix | Tributary to Blue River | General | 10/5/2016 |
| MO-G491089 | Hot Mix Materials, Inc. | Tributary to Blue River | General | 10/5/2016 |
| MO-G491177 | Clarkson Construction Co., Plant 6206 | Tributary to Blue River | General | 10/5/2016 |
| MO-G690060 | Loch Lloyd Community Lake | Tributary to Mill Creek | General | 3/13/2013 |
| MO-G760062 | Super Splash USA | Tributaty to Round Grove Creek | General | 4/9/2014 |
| MO-G970009 | Suburban Lawn and Garden | Tributary to Blue River | General | 11/29/2012 |
| MO-G970022 | Damon Purcell Construction Co. | Tributary to Blue River | General | 11/29/2012 |
| MO-G970026 | Lawn Corps, Inc. | Tributary to Mill Creek | General | 11/29/2012 |
| MO-R040015 | Grandview Small MS4 | Tributary to Blue River | Stormwater | 6/12/2013 |
| MO-R040018 | Belton Small MS4 | Tributary to Mill Creek | Stormwater | 6/12/2013 |
| MO-R040021 | Raytown Small MS4 | Tributary to Blue River | Stormwater | 6/12/2013 |
| MO-R104435 | Fairway Ridge Subdivision | Tributary to Mill Creek | Stormwater | 2/7/2012 |
| MO-R105063 | 7425 Stadium Drive | Tributary to Blue River | Stormwater | 2/7/2012 |
| MO-R109814 | State Line Station Unit # | Tributary to Blue River | Stormwater | 3/7/2012 |

| Permit No. | Facility Name | Receiving Stream | Permit Type | Permit Expiration Date |
|---|---|---|---|---|
| MO-R109AI9 | UMKC Oak Street West Development | Tributary to Brush Creek | Stormwater | 3/7/2012 |
| MO-R109FD8 | Blue River Pipeline Crossing | Blue River | Stormwater | 3/7/2012 |
| MO-R109FN3 | KC Police Dept. SPD SOD | Tributary to Blue River | Stormwater | 3/7/2012 |
| MO-R109GK7 | 6400 E. 40 Hwy. | Blue River | Stormwater | 3/7/2012 |
| MO-R109X52 | Swope Park Soccer Facility | Tributary to Blue River | Stormwater | 3/7/2012 |
| MO-R10A570 | Advance Stores Co., Inc. | Tributary to Blue River | Stormwater | 2/7/2012 |
| MO-R10A610 | The Townhomes at Royal Village | Tributary to Riss Lake | Stormwater | 2/7/2012 |
| MO-R10A676 | Kirkwood Circle | Tributary to Brush Creek | Stormwater | 2/7/2012 |
| MO-R10B045 | Superior Bowen Asphalt Co. | Tributary to Blue River | Stormwater | 2/7/2012 |
| MO-R10B131 | Holiday Inn Express | Tributary to Blue River | Stormwater | 2/7/2012 |
| MO-R10B152 | Armour Homes | Tributary to Blue River | Stormwater | 2/7/2012 |
| MO-R10B163 | Faith Estates | Tributary to Blue River | Stormwater | 2/7/2012 |
| MO-R10B197 | Rockhurst High School | Tributary to Dyke Branch | Stormwater | 2/7/2012 |
| MO-R10B254 | Riter Pump Station | Lake of Loch Lloyd | Stormwater | 2/7/2012 |
| MO-R10B292 | Swope Park Soccer Field 3 | Tributary to Blue River | Stormwater | 2/7/2012 |
| MO-R10B407 | Cerner Innovation Campus | Tributary to Blue River | Stormwater | 2/7/2012 |
| MO-R10B410 | Lot 40 Bi-State Business | Tributary to Blue River | Stormwater | 2/7/2012 |
| MO-R10B488 | Concord Woods | Tributary to Blue River | Stormwater | 2/7/2012 |
| MO-R10B622 | UMB Bank | Tributary to Brush Creek | Stormwater | 2/7/2012 |
| MO-R10C026 | Beck Tire | Tributary to Blue River | Stormwater | 2/7/2012 |
| MO-R10C041 | Parkway Baptist Church | Tributary to Blue River | Stormwater | 2/7/2012 |
| MO-R10C120 | Corner Plaza | Tributary to Blue River | Stormwater | 2/7/2012 |
| MO-R10C150 | Citadel Plaza | Tributary to Mill Creek | Stormwater | 2/7/2012 |
| MO-R10C221 | Centennial Business Park | Tributary to Blue River | Stormwater | 2/7/2012 |
| MO-R10D010 | United Believers Community Church | Tributary to Blue River | Stormwater | 2/7/2012 |
| MO-R10D085 | Saint Luke’s Health System | Tributary to Brush Creek | Stormwater | 2/7/2012 |
| MO-R10D096 | Swope Gardens | Tributary to Blue River | Stormwater | 2/7/2012 |
| MO-R10D333 | Truck Trailer and Hitch Center | Tributary to Blue River | Stormwater | 2/7/2012 |
| MO-R10D365 | Palestine Commons Independent Senior Living | Tributary to Brush Creek | Stormwater | 2/7/2012 |
| MO-R10D376 | Congregation of Jehovah's Witnesses | Tributary to Blue River | Stormwater | 2/7/2012 |
| MO-R10D467 | Brywood Centre Rehabilitation | Tributary to Blue River | Stormwater | 2/7/2012 |
| MO-R10D508 | McDonald's | Tributary to Blue River | Stormwater | 2/7/2012 |
| MO-R10D787 | Rockhurst University N. Garage | Tributary to Brush Creek | Stormwater | 2/7/2012 |

| Permit No. | Facility Name | Receiving Stream | Permit Type | Permit Expiration Date |
|---|---|---|---|---|
| MO-R10D946 | Ward Parkway Center | Tributary to Dyke Branch | Stormwater | 2/7/2012 |
| MO-R10D984 | Dollar General | Tributary to Blue River | Stormwater | 2/7/2012 |
| MO-R10E059 | St. Teresa's Academy Track and Field | Tributary to Brush Creek | Stormwater | 2/7/2012 |
| MO-R10E156 | Innovation Campus N. Parking | Tributary to Hart Grove Creek | Stormwater | 2/7/2012 |
| MO-R10E190 | Oak Street Parking Garage | Tributary to Blue River | Stormwater | 2/7/2012 |
| MO-R130032 | International Paper | Tributary to Blue River | Stormwater | 5/29/2013 |
| MO-R130111 | Cook's Ham, Inc. | Tributary to Blue River | Stormwater | 5/29/2013 |
| MO-R130130 | Pepsi Beverages Co. | Tributary to Blue River | Stormwater | 5/29/2013 |
| MO-R203101 | Labconco Corp. | Tributary to Blue River | Stormwater | 6/14/2014 |
| MO-R203157 | Thyssen Krupp Access Corp. | Tributary to Little Blue River | Stormwater | 6/14/2014 |
| MO-R203207 | The Bratton Corp. | Tributary to Blue River | Stormwater | 6/14/2014 |
| MO-R203252 | Automatic Systems, Inc. | Tributaty to Round Grove Creek | Stormwater | 6/14/2014 |
| MO-R203277 | A and A Bumper Plating, Inc. | Tributary to Rock Creek | Stormwater | 6/14/2014 |
| MO-R203297 | Clay and Bailey Manufacturing, Inc. | Tributary to Blue River | Stormwater | 6/14/2014 |
| MO-R203307 | Central Power Products, Inc. | Tributary to Blue River | Stormwater | 6/14/2014 |
| MO-R203332 | SPX Cooling Technologies | Tributary to Blue River | Stormwater | 6/14/2014 |
| MO-R23D029 | Nitto Denko Automotive | Tributary to Blue River | Stormwater | 2/3/2016 |
| MO-R23D048 | Peterson Manufacturing Co. | Tributary to Blue River | Stormwater | 2/3/2016 |
| MO-R60A008 | Langley Recycling, Inc. | Tributary to Big Blue River | Stormwater | 5/29/2013 |
| MO-R60A052 | Rich Industries, Inc. | Tributary to Blue River | Stormwater | 5/29/2013 |
| MO-R60A145 | Pick-n-Pull Auto Dismantlers | Blue River | Stormwater | 5/29/2013 |
| MO-R60A171 | C and H Auto Parts | Tributary to Blue River | Stormwater | 5/29/2013 |
| MO-R60A187 | All Star Auto Parts | Tributary to Blue River | Stormwater | 5/29/2013 |
| MO-R60A199 | C and H Auto Parts | Blue River | Stormwater | 5/29/2013 |
| MO-R60A251 | Late Model Auto Parts | Tributary to Blue River | Stormwater | 5/29/2013 |
| MO-R60A259 | Porter Auto Salvage | Tributary to Blue River | Stormwater | 5/29/2013 |
| MO-R60A260 | Little Will's Auto Salvage | Tributary to Blue River | Stormwater | 5/29/2013 |
| MO-R60A261 | Custom Truck and Equipment | Tributary to Blue River | Stormwater | 5/29/2013 |
| MO-R60A264 | Economy Auto Salvage | Tributary to Blue River | Stormwater | 5/29/2013 |
| MO-R60A266 | Marvin's Automotive, LLC | Tributary to Blue River | Stormwater | 5/29/2013 |
| MO-R60A269 | Jay's Salvage | Tributary to Blue River | Stormwater | 5/29/2013 |
| MO-R60A272 | AAA Auto Repair | Tributary to Blue River | Stormwater | 5/29/2013 |

| Permit No. | Facility Name | Receiving Stream | Permit Type | Permit Expiration Date |
|---|---|---|---|---|
| MO-R60A275 | Avenue Auto Wrecking, Inc. | Tributary to Blue River | Stormwater | 5/29/2013 |
| MO-R60A277 | A3 Auto Salvage and Wrecking | Tributary to Blue River | Stormwater | 5/29/2013 |
| MO-R60A279 | A3 Auto Wrecking | Tributary to Blue River | Stormwater | 5/29/2013 |
| MO-R80C399 | Durham School Services | Tributary to Blue River | Stormwater | 10/4/2012 |
| MO-R80C420 | Cragtree Harmon | Tributary to Blue River | Stormwater | 10/4/2012 |
| MO-R80C436 | First Student, Inc. | Tributary to Blue River | Stormwater | 10/4/2012 |
| MO-R80C495 | Superior Bowen Asphalt Co. | Tributary to Blue River | Stormwater | 10/4/2012 |
| MO-R80C496 | McCormack-Payton Co. | Tributary to Kernoodle Lakes | Stormwater | 10/4/2012 |
| MO-R80H086 | Material Recovery and Transfer | Tributary to Blue River | Stormwater | 7/23/2014 |
| MO-R80H123 | Manchester Transfer, LLC | Tributary to Blue River | Stormwater | 7/23/2014 |
| MO-RA00145 | Avila University Residence Hall | Tributary to the Blue River | Stormwater | 2/7/2017 |
| MO-RA00165 | Wayside Waifs | Tributary to Blue River | Stormwater | 2/7/2017 |
| MO-RA00783 | 4840 Roanoke | Tributary to Brash Creek | Stormwater | 2/7/2017 |
| MO-RA00875 | Molle VW Service Center | Tributary to Indian Creek | Stormwater | 2/7/2017 |
| MO-RA00894 | Rew Properties, LLC | Tributary to Blue River | Stormwater | 2/7/2017 |
| MO-RA00895 | Loch Lloyd Pkwy. and Res. Dev. | Mill Creek & Blue River | Stormwater | 2/7/2017 |
| MO-RA00899 | The Country Club of Loch Lloyd | Tributary to Mill Creek | Stormwater | 2/7/2017 |
| MO-RA00998 | Loch Lloyd Phase 1A | Tributary to Mill Creek | Stormwater | 2/7/2017 |
| MO-RA01000 | Ward Parkway Center | Tributary to Dyke Branch | Stormwater | 2/7/2017 |
| MO-RA01068 | UMKC MNL Classroom Add. | Tributary to Brush Creek | Stormwater | 2/7/2017 |
| MO-RA01093 | Dodson Industrial Park | Blue River | Stormwater | 2/7/2017 |
| MO-RA01096 | Tom Smith Lakes | Tributary to the Blue River | Stormwater | 2/7/2017 |
| MO-RA01133 | Blue River Channel Modification | Blue River | Stormwater | 2/7/2017 |
| MO-RA01246 | Dollar General - Truman Road | Tributary to Blue River | Stormwater | 2/7/2017 |
| MO-RA01299 | UMKC Bloch Hall Addition | Tributary to Brush Creek | Stormwater | 2/7/2017 |

## Kansas Construction and Industrial Permits in the Blue River and Indian Creek Watersheds

| Permit No. | Facility Name | Permit Type |
|---|---|---|
| G-MO14-0001 | US POSTAL SER OLATHE EAST BRANCH OFC | Industrial |
| G-MO14-0003 | JOHNSON CO EXECUTIVE AIRPORT | Industrial |
| G-MO14-0004 | KANSAS CITY AVIATION CENTER | Industrial |
| G-MO14-0005 | OLATHE DISTRIBUTION CENTER (TYSON) | Industrial |
| G-MO14-0006 | SYSCO KANSAS CITY, INC. | Industrial |
| G-MO27-0001 | TOMAHAWK CREEK WWTP | Industrial |
| G-MO28-0005 | DOUGLAS L SMITH MIDDLE BASIN WWTP | Industrial |
| G-MO28-0006 | BLUE RIVER MAIN WWTP | Industrial |
| G-MO30-0001 | CCBC OF MID AMERICA (COCA-COLA) | Industrial |
| G-MO30-0003 | FEDEX GROUND-HOME DELIVERY | Industrial |
| G-MO30-0004 | WILLIAMS FOODS (99TH ST.) | Industrial |
| G-MO30-0005 | FED EX EXPRESS - IXDA | Industrial |
| G-MO30-0007 | BRODERSON MANUFACTURING CORPORATION | Industrial |
| G-MO32-0001 | USPS OXFORD CARRIER ANNEX | Industrial |
| S-MO14-0015 | GREENWOOD BUSINESS CENTER | Construction |
| S-MO14-0025 | HUNTER'S CREEK | Construction |
| S-MO14-0034 | WILLOWBROOKE VILLAS | Construction |
| S-MO14-0035 | MAPLE BROOK PARK | Construction |
| S-MO14-0050 | FALLBROOK | Construction |
| S-MO14-0058 | MAE CREST | Construction |
| S-MO14-0065 | BRIGHTON'S LANDING, FIRST PLAT | Construction |
| S-MO14-0080 | HIGHLANDS OF KENSINGTON | Construction |
| S-MO14-0085 | SUMMERWOOD DEVELOPMENT | Construction |
| S-MO14-0090 | FAIRFIELD AT HERITAGE PARK - 1ST PLAT | Construction |
| S-MO14-0093 | HERITAGE MANOR - 1ST PLAT | Construction |
| S-MO14-0099 | COFFEE CREEK MEADOWS | Construction |
| S-MO14-0101 | MUR-LEN CROSSING | Construction |
| S-MO14-0104 | AVIGNON - 2ND PLAT | Construction |
| S-MO14-0105 | HERITAGE MANOR - 2ND PLAT | Construction |
| S-MO14-0112 | ASHFORD VILLAS | Construction |
| S-MO14-0113 | WYNGATE - 2ND PLAT | Construction |
| S-MO14-0114 | RIDGEVIEW ROAD (175TH ST. 7100' NORTH) | Construction |
| S-MO14-0116 | FAIRFIELD AT HERITAGE PARK - 2ND PLAT | Construction |
| S-MO14-0117 | FAIRFIELD AT HERITAGE PARK - 3RD PLAT | Construction |
| S-MO14-0119 | AUSTIN PARK - 1ST PLAT | Construction |

| Permit No. | Facility Name | Permit Type |
|---|---|---|
| S-MO14-0122 | NOTTINGTON CREEK - 5TH PLAT | Construction |
| S-MO14-0126 | FOREST HILLS ESTATES - 3RD PLAT | Construction |
| S-MO14-0127 | CULVERT REPLACEMENT 183RD ST OVER TRIB. | Construction |
| S-MO14-0128 | INDIAN CREEK ELEMENTARY SCHOOL | Construction |
| S-MO14-0129 | COUNTRY SIDE ELEMENTARY SCHOOL | Construction |
| S-MO14-0131 | AVIGNON - 3RD PLAT | Construction |
| S-MO14-0133 | OLATHE SOUTH HIGH SCHOOL | Construction |
| S-MO14-0134 | OLATHE EAST HIGH SCHOOL | Construction |
| S-MO14-0137 | SOUTH INDIAN CREEK TRAIL | Construction |
| S-MO14-0138 | BNSF WEST TRACK QUIET ZONE | Construction |
| S-MO14-0139 | LATERAL SEWER DIST NO 6 OF TOMAHAWK CRK | Construction |
| S-MO14-0140 | MP-05252 - 36" WATER TRANS. MAIN PROJEC | Construction |
| S-MO14-0141 | HARMONY VIEW WEST | Construction |
| S-MO14-0142 | AVIGNON - 5TH PLAT | Construction |
| S-MO14-0143 | HEATHER RIDGE - 3RD PLAT | Construction |
| S-MO14-0144 | FAMILY VIDEO - OLATHE, KS | Construction |
| S-MO14-0145 | HY-VEE, OLATHE #1 | Construction |
| S-MO14-0146 | HILTON GARDEN INN | Construction |
| S-MO27-0014 | SHOPS AT 119TH | Construction |
| S-MO27-0021 | MISSION CORNER | Construction |
| S-MO27-0022 | GLEN ABBEY OF LEAWOOD | Construction |
| S-MO27-0029 | IRONHORSE CENTRE, LOT 7 & 8 | Construction |
| S-MO27-0035 | SABATES EYE CENTERS | Construction |
| S-MO27-0036 | IRONWOODS POND | Construction |
| S-MO27-0037 | ESTATES OF OLD LEAWOOD | Construction |
| S-MO27-0038 | LEABROOKE - 5TH PLAT | Construction |
| S-MO27-0039 | CENTENNIAL PARK | Construction |
| S-MO27-0040 | GEZER PARK | Construction |
| S-MO27-0041 | LEABROOKE - 7TH PLAT | Construction |
| S-MO27-0042 | LEABROOKE - 6TH PLAT | Construction |
| S-MO27-0047 | CENTENNIAL PARK - OVERBROOK | Construction |
| S-MO27-0048 | POWER SPECIALTIES - LOT 12 BI-STATE BUS | Construction |
| S-MO27-0051 | LITTLE SUNSHINE'S PLAYHOUSE | Construction |
| S-MO27-0054 | BI-STATE CENTENNIAL PARK | Construction |
| S-MO27-0056 | LOT 1, TOWN CTR BUS. CTR, 5TH PLAT | Construction |
| S-MO28-0007 | ANTIOCH 127 | Construction |
| S-MO28-0029 | HERITAGE OF OVERLAND PARK | Construction |

| Permit No. | Facility Name | Permit Type |
|---|---|---|
| S-MO28-0058 | SOUTHCREEK BUSINESS PARK | Construction |
| S-MO28-0060 | RIVER RIDGE FARMS WEST 2ND PLAT | Construction |
| S-MO28-0065 | REGIONAL MALL | Construction |
| S-MO28-0080 | HAMPTON PLACE | Construction |
| S-MO28-0084 | TALLGRASS AT THE WILDERNESS | Construction |
| S-MO28-0087 | CRYSTAL SPRINGS | Construction |
| S-MO28-0094 | COMMERCIAL PARK | Construction |
| S-MO28-0097 | AGS APARTMENTS | Construction |
| S-MO28-0100 | MILLS FARM - 1ST PLAT | Construction |
| S-MO28-0127 | CHAPEL HILL - 1ST PLAT | Construction |
| S-MO28-0139 | POLO FIELDS | Construction |
| S-MO28-0146 | THE VINEYARD | Construction |
| S-MO28-0160 | DOUGLAS L. SMITH MIDDLE BASIN TREATMENT | Construction |
| S-MO28-0166 | COFFEE CREEK CROSSING - 3RD PLAT | Construction |
| S-MO28-0168 | OAK PARK MALL SHOPPING CENTER | Construction |
| S-MO28-0170 | BLUE VALLEY ELEMENTARY #22 (BLDG.) | Construction |
| S-MO28-0174 | PRAIRIEFIRE AT LIONSGATE | Construction |
| S-MO28-0181 | CRYSTAL SPRINGS - 3RD PLAT | Construction |
| S-MO28-0182 | MISSION 159 | Construction |
| S-MO28-0183 | OAK PARK MALL REDEVELOPMENT | Construction |
| S-MO28-0184 | MISSION FARMS WEST | Construction |
| S-MO28-0189 | HIGHLANDS VILLAGE | Construction |
| S-MO28-0190 | THE FARM AT GARNET HILL - 1ST PLAT | Construction |
| S-MO28-0194 | ADDITIONS & RENOVATIONS ON BLUE VALLEY | Construction |
| S-MO28-0195 | COLTON RANCH | Construction |
| S-MO28-0196 | BLUE VALLEY NORTH BASEBALL & SOFTBALL F | Construction |
| S-MO28-0199 | WOODS AT COLTON LAKE - 3RD PLAT | Construction |
| S-MO28-0200 | LAKESHORE | Construction |
| S-MO28-0201 | 151ST AND METCALF CENTER | Construction |
| S-MO28-0202 | CHILDREN'S MERCY SOUTH HOSPITAL | Construction |
| S-MO28-0203 | OVERLAND POINTE | Construction |
| S-MO28-0204 | WINCREST - LOT 4 | Construction |
| S-MO28-0205 | ROCKBROOK OFFICE PARK | Construction |
| S-MO28-0206 | COLONNADE OFFICE SUITES | Construction |
| S-MO28-0207 | CVS/PHARMACY #5271 | Construction |
| S-MO28-0208 | BLUE RIVER NO. 26 SAN SEWER INTERCEPTOR | Construction |
| S-MO28-0212 | DOUBLE TAKE SALON AND DAY SPA | Construction |

| Permit No. | Facility Name | Permit Type |
|---|---|---|
| S-MO28-0213 | US 69 - 75TH TO 95TH (KDOT 69-46 K8251- | Construction |
| S-MO28-0215 | STONEPOST RANCH | Construction |
| S-MO28-0216 | 159TH ST. AND ANTIOCH RD. STOCKPILE | Construction |
| S-MO28-0218 | KDOT 69-46 K-8251-07 (US 69 HWY RECONST | Construction |
| S-MO28-0219 | CHEROKEE SOUTH PLAZA | Construction |
| S-MO28-0220 | COFFEE CREEK CROSSING - 4TH PLAT | Construction |
| S-MO28-0221 | OSAGE PARK | Construction |
| S-MO28-0222 | 71ST TO 74TH, REEDS TO MAPLE | Construction |
| S-MO28-0223 | DOUGLAS L SMITH MIDDLE BASIN WWTP #19 | Construction |
| S-MO28-0224 | BLUE RIVER 10, CONTRACT DISTRICT 2 | Construction |
| S-MO28-0225 | CAMBRIDGE CHURCH | Construction |
| S-MO28-0227 | OAK PARK MALL SHOPPING CTR LOT 1, BLOCK | Construction |
| S-MO28-0228 | ELITE SQUAD TENNIS, INC. | Construction |
| S-MO28-0231 | SE CAMPUS QUADRANT URBAN STORMWATER MAN | Construction |
| S-MO28-0232 | BLUE VALLEY BAPTIST CHURCH | Construction |
| S-MO28-0233 | KIDDI KOLLEGE | Construction |
| S-MO28-0235 | WILSHIRE FARMS - 6TH PLAT | Construction |
| S-MO28-0236 | MEADOWS OF MILL FARM | Construction |
| S-MO28-0237 | 143RD STREET (QUIVIRA TO SWITZER) | Construction |
| S-MO28-0238 | 2010 MAJOR STORM REPAIR SECTION A & B | Construction |
| S-MO28-0239 | MEADOWS OF MILLS FARM, 2ND PLAT | Construction |
| S-MO28-0240 | OVERLAND PARK ASPHALT PATH-LAMAR AVE 13 | Construction |
| S-MO28-0241 | MILLS FARM, 8TH PLAT | Construction |
| S-MO28-0242 | BURGER KING | Construction |
| S-MO28-0243 | ISLAMIC CENTER OF JOHNSON COUNTY | Construction |
| S-MO28-0244 | 127TH ST. RECONSTRUCTION | Construction |
| S-MO28-0245 | OVERLAND PARK ARBORETUM LPS | Construction |
| S-MO28-0246 | STONEPOST RANCH RETAIL PHASE I | Construction |
| S-MO30-0010 | COLLEGE CROSSINGS NORTH | Construction |
| S-MO30-0011 | COLLEGE CROSSINGS SOUTH | Construction |
| S-MO32-0011 | RIVER RIDGE FARMS WEST 6TH PLAT | Construction |
| S-MO32-0019 | LAKE AT SOUTHWICK - PHASE 2 | Construction |
| S-MO32-0020 | OAKLEAF RIDGE - 2ND PLAT | Construction |
| S-MO32-0021 | BLUE RIVER NO 25, CONTRACT 1 GRAVITY SE | Construction |
| S-MO32-0022 | 160TH TERR. & KRANKER DR. IMPVS. | Construction |
| S-MO32-0023 | CULVERT V.84-2.35 LOCUST ST OVER TRIB C | Construction |
| S-MO32-0024 | M&H PARKING LOT EXPANSION | Construction |

| Permit No. | Facility Name | Permit Type |
|---|---|---|
| S-MO32-0025 | VILLAS OF RIVER RIDGE FARMS | Construction |

# Appendix C

## Blue River Watershed Combined Sewer Overflows in the Kansas City, Missouri Water Services Department Overflow Control Plan

| MDNR Outfall ID | Location Description | Typical Year Annual Overflow Volume (MG) | Estimated Recreation Season Overflow Volume (MG)[1] |
|---|---|---|---|
| 6 | 50th & Stateline | 0.00 | 0.00 |
| 7 | 50th Terrace & Brush Creek | 0.70 | 0.30 |
| 8 | 49th Terrace & Westwood Road | 15.67 | 1.98 |
| 9 | 50th & Holly | *included with 008* | 0.09 |
| 10 | 50th & Brush Creek | 0.17 | 0.01 |
| 11 | Roanoke & Brush Creek | 3.73 | 0.66 |
| 12 | Summit & Brush Creek | 0.04 | 0.04 |
| 13 | 47th & Wornall | 0.26 | 0.14 |
| 14 | 49th & Wornall | 0.14 | 0.06 |
| 15 | Nichols Road & Wornall | 0.44 | 0.24 |
| 16 | Main Street & Brush Creek | 0.00 | 0.00 |
| 17 | 46th Terrace & Wornall | 57.90 | 0.71 |
| 18 | 48th & Harrison | 113.44 | 0.26 |
| 19 | 49th & Troost | 3.05 | 2.09 |
| 20 | 48th & The Paseo | 52.27 | 0.37 |
| 21 | 47th & The Paseo | 201.07 | 1.63 |
| 23 | 46th & Woodland | 14.19 | 9.68 |
| 24 | 45th & Garfield | 31.80 | 0.37 |
| 25 | 46th & Prospect | 2.74 | 1.97 |
| 26 | 49th & Chestnut | 12.20 | 0.07 |
| 27 | 45th & Mersington | 21.90 | 0.34 |
| 28 | 46th & Norton | 0.31 | 0.04 |
| 29 | 51st Terrace & Brookside | 116.35 | 0.14 |
| 30 | 4200 Brush Creek | 807.77 | 1.03 |
| 32 | Belmont Avenue & Belmont Blvd. | 0.08 | 0.36 |
| 33 | Wilson & Bennington | 676.38 | 238.11 |
| 34 | 8th Street at Blue River | 5.97 | 2.44 |
| 36 | 18th Street at Blue River | 30.17 | 18.68 |
| 37 | 35th Street at Blue River | 57.44 | 5.03 |
| 39 | 33rd Terrace & Topping | 73.63 | 42.76 |
| 40 | 41st & Elmwood | 22.80 | 2.72 |
| 41 | 40th & Cleveland | 7.51 | 0.00 |
| 43 | 40th Terrace & Cleveland | 1.40 | 0.00 |
| 44 | 40th Terrace & Myrtle | 0.02 | 0.00 |
| 45 | 41st & Myrtle | 0.00 | 0.00 |
| 46 | 41st Norton | 0.00 | 0.00 |
| 47 | 41st & Jackson | 0.52 | 0.00 |

| MDNR Outfall ID | Location Description | Typical Year Annual Overflow Volume (MG) | Estimated Recreation Season Overflow Volume (MG)[1] |
|---|---|---|---|
| 48 | 45th Terrace & Lister | 1.85 | 0.02 |
| 49 | 41st & Spruce | 0.00 | 0.00 |
| 50 | Spruce & Towers Road | 1.84 | 0.00 |
| 51 | Skiles & Winner Road | 2.02 | 1.68 |
| 52 | Truman & Crystal | 1.03 | 0.00 |
| 54 | 17th & Belmont | 3.56 | 0.00 |
| 55 | I-70 & White | 0.75 | 2.82 |
| 56 | 55th & Elmwood | 9.67 | 7.03 |
| 57 | 76th & Indiana | 2.61 | 1.46 |
| 58 | 83rd Terrace & McGee | 3.23 | 0.32 |
| 59 | 85th & Tracy | 17.11 | 6.79 |
| 60 | 58th & Kensington | 3.08 | 2.23 |
| 61 | 58th & Elmwood | 8.09 | 5.87 |
| 62 | 63rd Terrace & Elmwood | 5.40 | 3.94 |
| 63 | 69th & Cleveland | 10.19 | 0.00 |
| 64 | Gregory & Mersington | 1.06 | 0.15 |
| 65 | 81st Terrace & Campbell | 0.02 | 0.00 |
| 66 | 84th & Main | 0.07 | 0.03 |
| 67 | 83rd & Main | 8.17 | 0.27 |
| 68 | 85th & Flora | 2.10 | 1.56 |
| 69 | 77th & Prospect | 69.38 | 19.50 |
| 70 | Meyer at Blue River | 0.48 | 0.31 |
| manholes | various locations | 8.40 | 0.00 |
| 79 | 51st & Indiana | 4.70 | 1.30 |
| 80 | 53rd & Walrond | 7.61 | 0.77 |
| 81 | 53rd Terrace & Walrond | 25.88 | 0.00 |
| 82 | 55th & Indiana | 7.44 | 0.02 |
| 83 | 57th & Agnes | 8.12 | 5.42 |
| 85 | 59th & Prospect | 7.12 | 0.44 |
| 89 | 61st Terrace & Park | 0.30 | 0.22 |
| 90 | 63rd & Highland | 224.70 | 0.75 |
| 91 | 59th & Bellefontaine | 9.84 | 0.07 |
| 92 | Gregory & Tracy | 19.88 | 11.54 |
| 93 | Gregory & Tracy | 1.00 | 0.56 |
| 94 | 69th Terrace & Lydia | 5.57 | 3.98 |
| 95 | 69th & Flora | 7.39 | 4.23 |
| 96 | 68th & Woodland | 1.63 | 1.22 |
| 97 | 66th Terrace & Flora | 1.96 | 0.00 |
| 99 | 56th & Bellefontaine | 4.17 | 2.67 |
| manholes | various locations | 3.68 | 3.83 |

1 Projected estimated recreation season overflow volume following implementation of the Overflow Control Plan.

# Appendix D

# Development of Bacteria Load Duration Curves

## Overview

A load duration curve approach was used to develop the TMDLs for the impaired drainage areas of Blue River (WBIDs 0417, 0418, 0419 and 0421) and Indian Creek (WBID 0420). The flow duration curve for this area was developed using a synthetic flow record. The load duration curve method allows for characterizing water quality concentrations (or water quality data) at different flow regimes and estimating the load allocations and wasteload allocations for each impaired segment. This method provides a visual display of the relationship between stream flow and loading capacity. Using the duration curve framework, allowable loadings are easily presented.

## Methodology

Using a load duration curve method requires a long time series of flow data, numeric water quality targets, and bacteria data from the impaired streams. Bacteria data from the impaired segments, along with the flow measurements for the same date, are plotted along with the load duration curve to assess when the water quality target is exceeded.

A long record of average daily flow data from a gage or multiple gages that are representative of the impaired reach are used to develop the load duration curve. Therefore, the flow record should be of sufficient length to be able to calculate percentiles of flow (typically 20 years or more). If a flow record for an impaired stream is not available, then a synthetic flow record is needed. To develop a synthetic flow record, a user should calculate an average of the log discharge per square mile of USGS gages from rivers for which the drainage area is contained within a single Ecological Drainage Unit. For this TMDL, six gages with sufficient flow records were available within the Blue River watershed itself (Table D.1). However, because none were directly representative of the stream discharge associated with each of the impaired segments, a synthetic flow record was developed. From this synthetic record, a flow duration curve was developed (Figure D.1).

The selected watershed targets are multiplied by the flow and a conversion factor to generate the allowable load at different flows. With this load duration curve, the targeted concentration is constant at all flow percentiles to reflect the static nature of the water quality standards. The targets used for these load duration curves were the recreation season geometric mean whole body contact recreation category A criterion of 126 *E. coli* counts per 100 mL of water, and the category B criterion of 206 *E. coli* counts per 100 mL of water. The maximum allowable loading capacity is then expressed as a daily target of *E. coli* counts per day across a range of flows.

**Table D.1 USGS gage stations used to derive synthetic flow for Blue River and Indian Creek impaired segments**

| Station Name | Station Number | Drainage Area ($mi^2$) | Discharge Record Used | Latitude/ Longitude | Nash-Sutcliffe Statistic |
|---|---|---|---|---|---|
| Blue River at Stadium Dr. Kansas City, MO | 06893578 | 256 | 2002 – 2010 | N39°03'30", W94°30'42" | 75% |
| Blue River at Kansas City, MO | 06893500 | 188 | 1990 – 2010 | N38°57'25.2", W94°33'32" | 95% |
| Blue River at Kenneth Rd. Overland Park, KS | 06893100 | 76 | 2003 – 2010 | N38°50'32", W94°36'44" | 46% |
| Blue River near Stanley, KS | 06893080 | 46 | 1990 – 2010 | N38°48'45", W94°40'32" | 99% |
| Indian Creek at State Line Rd. Leawood, KS | 06893390 | 64 | 2003 – 2010 | N38°56'18", W94°36'28" | 89% |
| Indian Creek at Overland Park, KS | 06893300 | 27 | 1990 – 2010 | N38°56'26", W94°40'16" | 95% |

**Figure D.1 Synthetic flow duration curve, Blue River and Indian Creek**